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ABSTRACT

This document is one of five learning packets on alternative energy developed as part of a descriptive curriculum research project in Arkansas (see note). The overall objectives of the learning packets are to improve the level of instruction in the alternative energies by vocational exploration teachers, and to facilitate the integration of new content on energy into existing vocational programs. Each learning packet contains unit objectives, information, transparency masters, lecture outline, suggested activities, student assignment sheets, tests, and answers to the tests. This unit on energy conservation covers the following topics: energy conservation through passive solar design; building small to conserve energy; insulation; the Arkansas Energy Conservation Home; conservation for existing construction, including weather stripping and caulking, insulation, heating and cooling equipment, and appliances; and a home energy check list. A glossary and a bibliography also are included. (KC)

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C O N S E R V A T I O N

Instructional Materials

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UNDER CONTRACT TO
State of Arkansas Department of Education
Division of Vocational, Technical, and Adult Education

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USE OF THIS PUBLICATION

The overall objective of this publication is to improve the level of instruction in the alternative energies by vocational exploration teachers.

The development of alternative sources of energy and the increasing demand for energy conservation require that vocational educators develop new curriculum and improve existing delivery systems. All vocational education instructors must begin to acquire a minimum background in alternative energy sources and must be prepared to respond in a positive way to the energy education needs within their areas of specialization. It is anticipated that the use of this prepared learning package will facilitate the integration of new content on energy into existing vocational programs.

INSTRUCTIONAL UNIT

This packet contains objectives, information, transparency masters, lecture outline, suggested activities, student assignment sheets, tests and answers to the tests. These materials have been printed on colored paper to code their use. The following key will help easily identify each use by color:

White - teacher instructional materials

Green - information materials, teacher and student use

Yellow - student assignment materials

Golden - tests, teacher controlled

Pink - answers to tests and assignments, teacher use only

One set of each is included in the learning packet. The teacher should reproduce enough of the student use materials to adequately furnish his class with the proper materials.

Objectives

Included in the packet are measurable objectives. These objectives state the goals of the unit of study in such a way that both teacher and student will know what performance is expected.

Information Sheets

Each unit of instruction has information sheets which contain essential facts for that unit. These sheets are coded green and are intended for both teacher and student use. If inadequate information is contained in the student textbook, the teacher may reproduce these sheets for student use.

Instructional Materials

Instructional materials included with the unit contain transparency masters, suggested teaching activities, a lecture outline and a bibliography. These sheets are white and intended for teacher use. Each teacher is encouraged to consider these materials as a starting point and to develop additional activities and teaching materials to meet specific needs.

Student Assignment Sheets

Assignment sheets are included to give students an opportunity to apply knowledge and skill acquired through reading assignments, lecture and practice. These sheets are yellow and may be reproduced for student use.

Tests

A test is included in each unit to enable the teacher to measure student achievement. These sheets are golden and should be reproduced only for testing purposes.

Answers

Answers to student assignments and tests follow each assignment or test. These are coded pink and should be restricted to teacher use only.

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UNIT OBJECTIVES

- To develop positive attitudes relating to use and conservation of energy.
- To develop problem-solving and creative techniques in working with energy systems.

SPECIFIC OBJECTIVES

- The student will demonstrate at an accuracy rating of 75% or above his knowledge of the five (5) basic types of "passive solar" designs.
- The student will demonstrate at an accuracy rating of 75% or above his knowledge of the ideas and concepts in the "Arkansas Story".
- The student will demonstrate at an accuracy rating of 75% or above his knowledge of how to make an older home more energy efficient.

OUTLINE OF SECTION I (PASSIVE SOLAR)

I. INTRODUCTION

- A. Definition of Passive Solar Design
- B. Advantages and Disadvantages

II. FIVE BASIC SYSTEM TYPES

- A. Direct Gain
- B. Convective Loops
- C. Thermal Storage Walls
- D. Thermal Storage Roofs
- E. Attached Sunspaces
- F. Advantages and Disadvantages of Five Basic System Types

OUTLINE OF SECTION II (BUILDING DESIGN)

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- C. Equipment (Heating and Cooling)
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- E. Vapor Barriers
- F. Attic Ventilators

III. "THE ARKANSAS STORY"

A. Standards for the Arkansas Energy Conservation Home in Little Rock

B. Summary

OUTLINE OF SECTION III (EXISTING CONSTRUCTION)

I. INTRODUCTION

II. WEATHER STRIPPING AND CAULKING

A. Weather Stripping

B. Caulking

III. INSULATION

A. Types of Insulation

B. Where to Insulate

IV. HEATING AND COOLING EQUIPMENT

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SECTION I (PASSIVE SOLAR) INFORMATION

INTRODUCTION

The initial phase of the second part of the ALTERNATIVE ENERGY CURRICULUM begins with a discussion of PASSIVE SOLAR ENERGY DESIGN. It is noted that this topic did receive some attention in the first part (Solar Energy) of the curriculum. But passive design warrants additional consideration because many experts in the field feel that in the very near future a major shift will be undertaken to change from the current techniques of home construction to those that incorporate facets of passive solar energy design.

It is a fact that most housing designs today, while trying to incorporate energy saving features, run the risk of being energy obsolete and overly costly long before the homes have reached their life usefulness termination point. The ultimate outcome of increased energy costs will be a rising demand for "passive" solar homes. The consumer and the federal government will become the forces behind the shift from present design to "passive" design. The change is coming no matter how much we try to shut out the facts. It is important that a student of today learn about "passive" solar design because many will be faced with the necessity of using it in the future.

Definition of Passive Solar Design

The following is a formal definition of "passive solar design":

> Passive solar designs are methods for heating or cooling buildings or for heating domestic water in which thermal energy flows by natural means (i.e., without pumps or fans).

This definition differs from a common perception of solar heating and cooling systems. It is often assumed that using solar energy requires an assemblage of components that include an array of collectors, a thermal energy storage system, and two thermal energy transport systems - one between the collecto and storage, and another between storage and the heated or cooled building.

Both transport systems ordinarily use pumps or fans. These systems are often termed "active" because of the moving parts and power requirements of the fans or pumps. Further, the components are usually attached to or installed in a building without greatly affecting the building's architectural fabric (roof, walls, floor, etc.).

Advantages and Disadvantages

When compared with active systems, passive solar designs have both advantages and disadvantages. Most advantages stem from the inherent simplicity of passive systems. This simplicity generally results in greater reliability, lower costs, and longer life.

Since passive systems have few or no moving parts and usually employ conventional building materials, their performance is reliable. Windows and walls perform their task effortlessly and quietly without mechanical or electrical requirements. Generally, there are no wearing surfaces or need of lubrication. If any external control is required (e.g. shutters), it is usually a simple task performed by the occupant. Using conventional building materials such as glass, concrete, and brick involves well-known techniques and these materials are generally long-lasting.

Simplicity, low initial costs of conventional materials, low maintenance costs, and long lifetimes all contribute to the cost effectiveness of well designed passive systems. But perhaps the most significant reason for passive design's cost effectiveness is the long lifetime. For the life of the building, a passive system should continually maintain, if not improve, its value in at least equal proportion to the rest of the building. It should require no more maintenance than any other wall or roof.

From the viewpoint of society as a whole, passive solar offers many benefits. The most obvious is a saving of fossil fuels which help the economy and preserves these resources for their optimum applications. The economy profits both by reducing the balance of payment deficits and freeing capital from fossil fuel expenditures for better uses. The decrease in fossil fuel use also has a beneficial environmental impact. After installation solar heating and cooling require few, if any, transmission lines, pipe lines, or strip mines; it produces no dangerous radioactive wastes and no polluted air or water. Solar systems have few negative impacts since they use materials that are renewable and can be recycled.

The primary disadvantages to passive designs are:

1. It increases construction cost.
2. Extreme care must be taken to make a house water-tight if any portion of it will be put underground.
3. Lack of public education concerning the use of passive solar energy design.
4. Buyer wariness due to radical appearance of design in many cases.

Most of the disadvantages are related to market acceptability by home buyers and the building industry.

FIVE BASIC SYSTEM TYPES

Passive solar designs can be categorized in diverse ways. Also, as noted earlier, overlap is inevitable. The approach used here is to describe five methods:

A. Direct Gain
B. Convective Loops
C. Thermal Storage Walls
D. Thermal Storage Roofs
E. Attached Sunspaces

Direct Gain

Direct gain systems use solar radiation that enters through glass or plastic directly into the space to be heated. Nearly all of the solar radiation entering the room is immediately converted to heat. Thermal mass for storing excess solar heat is most effective when located with direct exposure to the sunlight (as in a concrete floor). To reduce heat loss and, therefore, to increase overall thermal performance, insulation may be applied at night to the glass, either inside or outside. During the heating season, south-facing glass takes advantage of the sun's low position in the sky; in the summer when the sun is high in the sky, the glass is shaded by overhang, awnings, or trees. See Fig. A-1, Direct Gain.

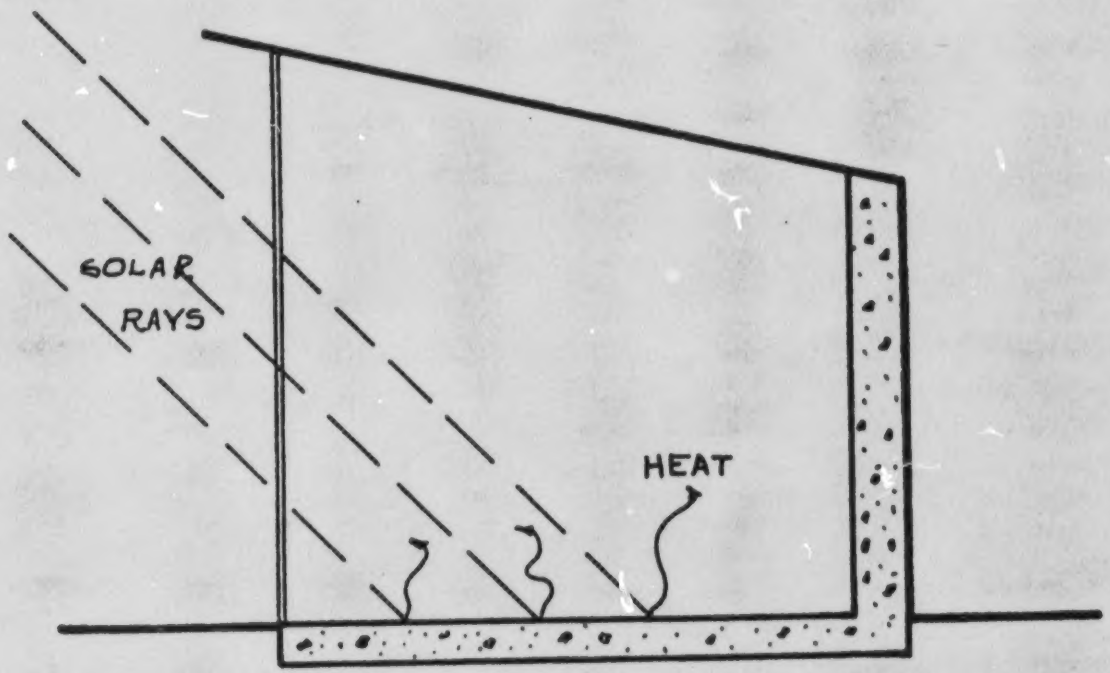


Fig. A-1 - Direct Gain

Convective Loops

Fig. A-2 below illustrates the simplest form of a convective loop air collector. As the air in the space between the glass and the blackened absorber surface is heated, it expands and becomes lighter, rises through the collector, and flows into the room through a vent at the top. Cooled room air, drawn into the collector through another vent at the base of the wall replaces the warmed air leaving the collector. It is then heated and subsequently expelled from the top of the collector into the room. This process continues as long as there is enough solar radiation to raise the temperature of the collector above the temperature of the room.

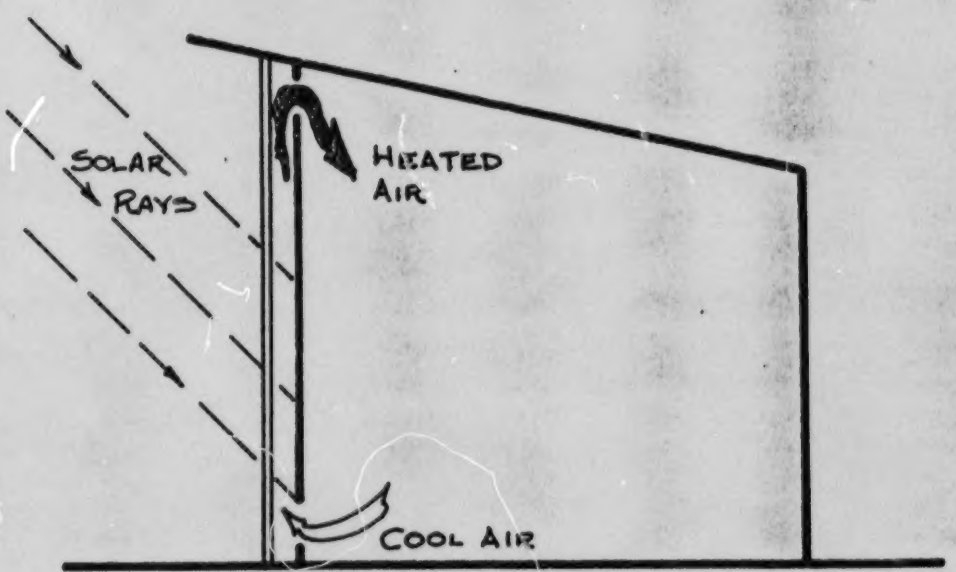


Fig. A-2 - Convective Loop Air Collector

Thermal Storage Walls

In many applications of passive solar heating, thermal energy storage is located between a wall of glass (or plastic) and the space to be heated. To date, there are two types of thermal storage walls. One uses heavy masonry materials 1 foot thick. The outside surface of the wall, painted a darker color, heats up as the sun irradiates it. The heat is conducted through the wall and is then transmitted to the interior spaces by convection and radiation several hours after the sun's energy strikes the wall.

The second general type of thermal storage wall employs water instead of masonry materials. Tubes of water, 55-gallon drums, and specially fabricated water walls are commonly used. Although some heat may be transferred by the convective loop, most of the heat is absorbed by the water then radiated directly to the room.

To control this radiation heating, a partition can be placed between the water wall and the room. A thermostatically controlled fan could then be used to directly supply warm air from the resulting warm water wall "closet" to the living space.

In masonry thermal storage walls, vent holes are frequently placed at the top and bottom to allow room air to enter, rise in the warm space between the storage wall and the glass, and re-enter the room. This combines the convective loop process with a thermal storage wall. Such systems are usually referred to as "Trombe Walls" after Felix Trombe of Odeillo, France, who gave a substantial boost to their development.

Fans can be used to increase and control air flow. Even when vents are used, however, the majority of the heat is absorbed by and conducted through the masonry material. In many systems, manual or automatic dampers prevent the

nighttime reverse flow of air that would cool the space. As with direct gain systems, movable insulation may be used to cover the glass at night to reduce heat loss and thereby increase overall thermal performance, especially in cold climates. See Fig. A-3 below - Thermal Storage Wall with Thermocirculation Vents.

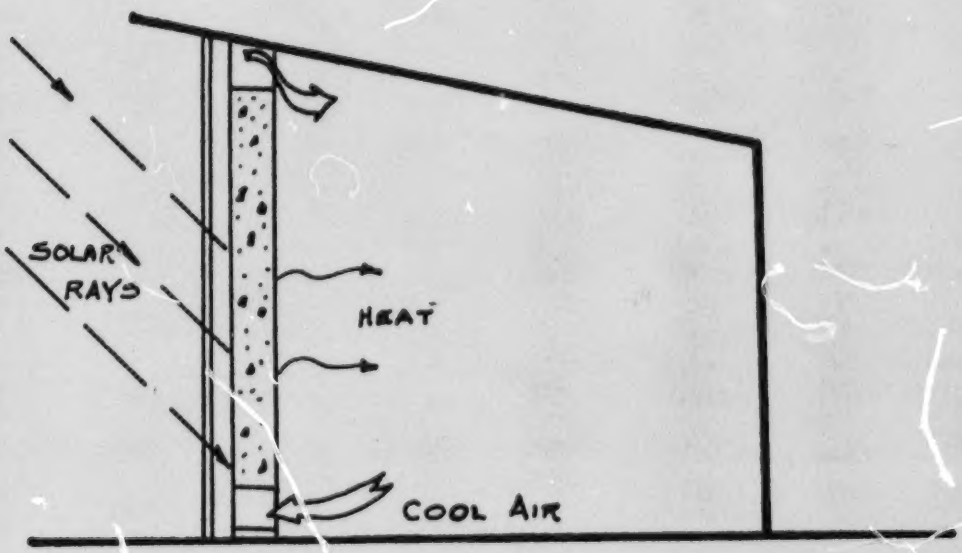


Fig. A-3 - Thermal Storage Wall with Thermocirculation Vents

Thermal Storage Roofs

Some passive designs locate the thermal storage on the roof. The most widely known system, developed by Harold Hay, is called "Skytherm". It uses roof ponds of water storage in large clear vinyl bags that are supported on a black, waterproof liner. Solar radiation is absorbed both by the water and the black liners. This heat is then conducted through the ceiling, in contact with the bags, to the space below. Insulation panels cover the roof ponds at night to minimize heat loss.

Depending on the climate, this system can be used for cooling during the summer. The water absorbs heat from the space below and radiates the heat to the cold night sky through a process called nocturnal radiative cooling. By flooding the water bags, evaporative cooling can be used effectively. The insulating panels cover and shade the roof ponds during the day and are removed at night to permit radiative and evaporative cooling as well as convective cooling when the outdoor air is cooler than the pond.

Other variations, developed for heating in colder climates, use glazing incorporated into a south-sloping roof pitch and water containers or "thermoponds" supported by the ceiling. See Fig. A-4 - SKYTHERM^{R} - Thermal Storage Roofs, Summer and Winter Operation on following page.

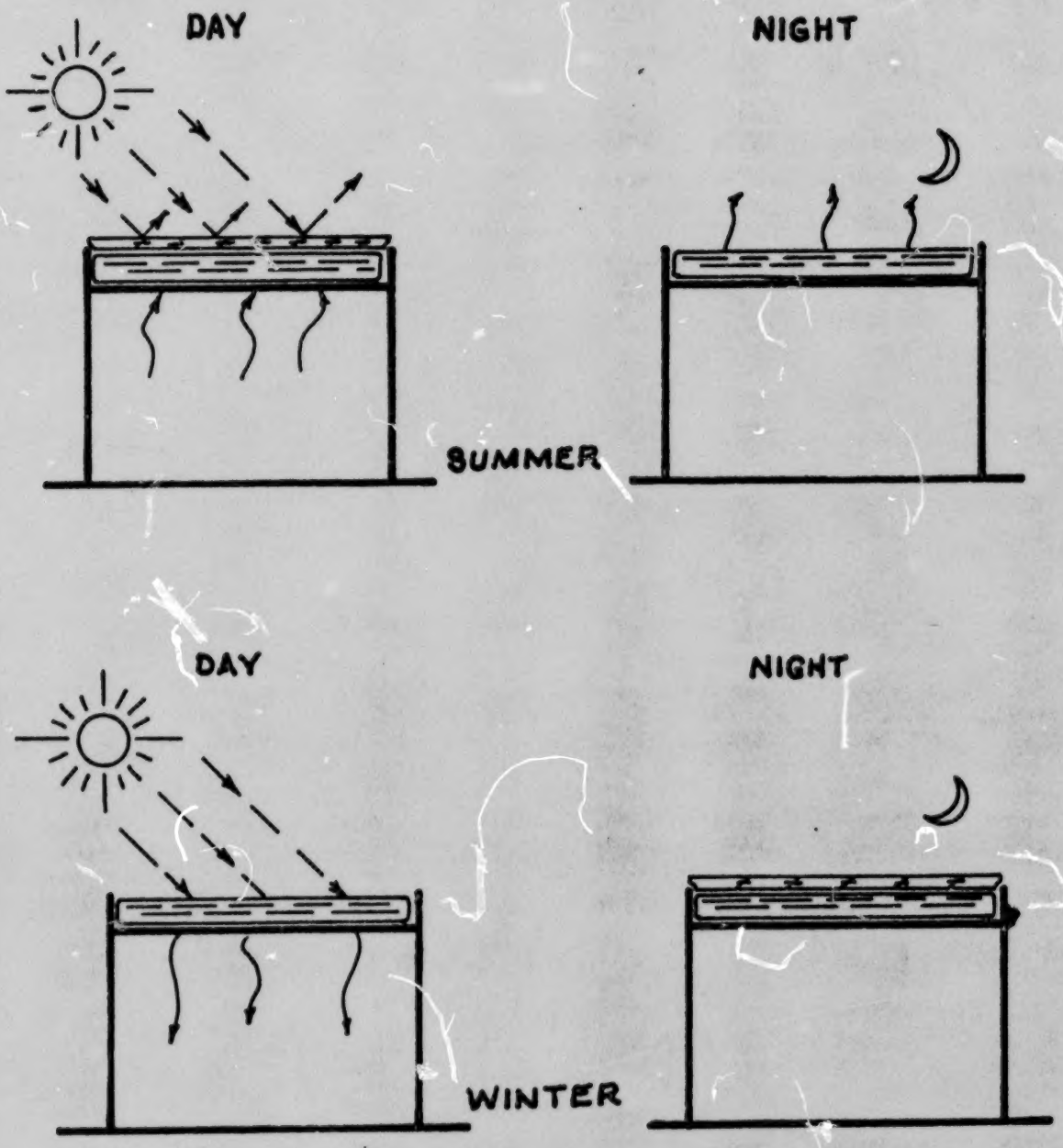


FIG. A-4 -SKYTHERM^{R} - Thermal Storage Roofs, Summer and Winter Operation

Attached Sunspaces

Greenhouses and other "solar" rooms can be attached to new or existing buildings. Overheated sunspace air is either delivered directly to the building to be heated, or the building and the sunspace can have a common thermal storage wall or rock bed. The heat stored in the thermal storage wall will be shared by both the sunspace and the building. Some of the heat from the wall warms the greenhouse before passing to the outdoors, thereby extending the growing season. At the same time, the wall helps to keep the greenhouse from becoming overheated on clear, sunny days. Solar energy can provide all, or nearly all, of the heat required by a properly designed space. The sunspace provides substantial quantities of excess energy to heat the building while simultaneously acting as a buffer zone to reduce heat loss from the building to the outdoors. See Fig. A-5 - Solar Greenhouse.

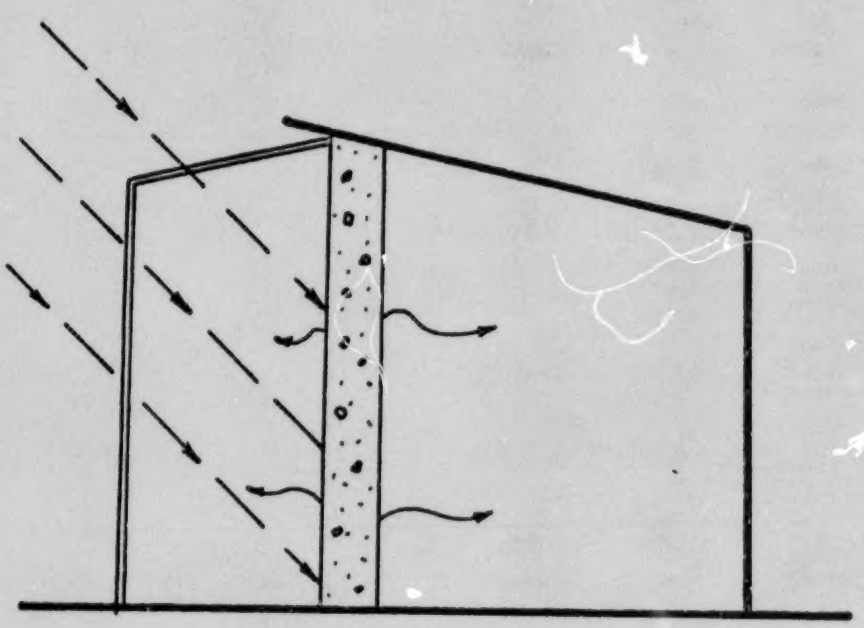


Fig. A-5 - Solar Greenhouse

Advantages and Disadvantages of Five Basic System Types

Direct Gain

Advantages -

a. Glazing is a relatively inexpensive form of solar collector and is widely available and thoroughly tested.

b. The overall system can be one of the least expensive means of solar heating.

c. Direct gain is the simplest solar energy system to conceptualize and can be the easiest to build. In many instances it is achieved by relocating windows.

d. The glazing serves multiple functions - allows solar radiation to enter the building while admitting natural daylight and providing visual access to the outside.

Disadvantages -

a. Large expanses of glass can result in too much glare during the day and loss of privacy at night.

b. Ultraviolet radiation in the sunlight will degrade fabrics and photographs.

c. Thermal mass is expensive, particularly if it serves no structural purpose.

d. Providing for reduced hear loss at night through the glazing can be expensive and awkward.

Convective Loops

Advantages -

a. Convective loops provide one of the least expensive ways to solar heat.

b. They are easily adaptable to existing buildings.

Disadvantages -

a. Both careful engineering and construction are required to ensure proper air flow and adequate thermal insulation at night.

b. This method provides a poor storage medium.

Thermal Storage Walls

Advantages -

a. Glare and ultraviolet degradation of fabrics are not problems.

b. Temperature swings in the living space are lower than with direct gain or convective loop systems.

c. The time delay between the absorption of radiant energy by the surface and the delivery of the resulting heat to the space provides warmth in the evening when most residences need it.

d. The state-of-the-art in analyzing thermal storage walls is well advanced.

Disadvantages -

a. Two south walls, a glazed wall and a mass wall, are needed.

b. The mass wall occupies valuable space within the building.

c. In cold climates considerable heat is lost to the outside from the warm wall through the glazing unless the glazing is insulated at night. Movable insulation tends to be expensive and awkward.

Thermal Storage Roofs

Advantages -

a. Compared with many passive systems, the heating and cooling effects are more uniformly distributed throughout the building.

b. Temperature swings in the building may be small.

c. Glare and ultraviolet degradation are not problems.

d. This system can provide both heating and cooling.

e. Back-up heating and cooling systems can be eliminated in mild climates.

Disadvantages -

a. The heavy weight of the thermal mass above the ceiling might be psychologically unacceptable (especially in the earthquake prone areas).

b. The thermal storage roof area needs to be at least 50 percent of the total floor area to produce a significant fraction of the thermal energy needs of the building.

c. Structural support for the heavy mass can be costly.

Attached Sunspaces

Advantages -

a. Temperature swings in the adjacent living spaces are small.

b. They provide space for growing food and other plants.

c. They reduce heat loss from buildings by acting as buffer zones.

d. They are readily adaptable to existing buildings.

Disadvantages -

a. Thermal performance varies greatly from one design to another, making the performance difficult to predict.

b. Although construction costs can be kept low, commercial quality construction is expensive.

INTRODUCTION

Many things go into the planning of a new home. Among these considerations, one should put at the top of the list the question of HOW ENERGY EFFICIENT IS IT? If it is not energy efficient it will not be able to cope with the future of ever increasing energy costs. The best way to get a home that can cope with the future is to design and build it from scratch. The basic principle behind the design will be simple: the house must gather as much energy as possible from its environment, and must then make use of every bit of energy it has gathered.

Several guidelines are presented here for your consideration.

Think Small

Thinking "small" is the basic rule for energy efficiency. The smaller your home, the less energy it takes to run it. You may reduce the size of your home by using bunkbeds or sleeping loft arrangements. Do not use a separate dining room. Combine rooms wherever possible. Using this technique gives a more open spacious feeling to your home.

Use Efficient Shapes

You should enclose as much space as possible with the least amount of wall and roof exposure to the weather. The ideal shape is the dome. It encloses the greatest amount of space with the least amount of exterior side.

One should consider a second or third floor. Adding a second floor can double your living space without any increase in roof area.

Wise Placement

The way your home sits on its land should be determined by the sun and the wind. The main window area of the home should face south. This will let you collect solar heat with your windows.

Build Underground

A home built underground can take advantage of the fact that the ground temperature a few feet below the surface will remain about 50 degrees F. all year long. This home would lose little heat in the winter and would remain cool in the summer.

Take Advantage of Landscaping

Using trees and shrubs for sunscreens is a cheap, natural way to temper your environment. Landscaping should not be limited to sun control alone. It is also an effective way to control wind. In one study made in Nebraska, it was discovered that a windbreak of trees can reduce winter heating costs by as much as 30 percent.

Trees can cool your home even without shading it directly. Their shade prevents the earth from absorbing heat; their transpiration process works like evaporative cooling. A grouping of deciduous trees can lower air temperature around your home by as much as 15 degrees during the summer time.

INSULATION

One of the primary concerns of the home owner should be the amount of insulation that he has in his home. Quality insulation, properly applied, is the key to reducing winter heat loss and summer heat gain in the home. Insulation efficiency is indicated by the R-Value. The higher the R-Value, the more efficient the insulation will be.

Below are insulation recommendations made by the Arkansas Power and Light Co. They are intended to be used in new construction or whenever possible in addition to existing construction.

Recommendations

1. Exterior Walls: R-19 insulation carefully fitted between 2-inch by 6-inch studs, 24 inches on center (6-inch batts or equivalent).

2. Ceiling: Two batts of R-19 6-inch insulation for a total resistance of R-38. Batts should be fitted snugly to eliminate air spaces and should be extended full thickness to the outside edge of the walls. This requires a modified truss construction to provide a 12-inch space between ceiling and rafters at the outside wall.

3. Floors: R-19 batt insulation is recommended for floors over a crawl space or basement. Batts should be suspended between the floor joists with wire clips. For slab floors, 1½ inch urethane board (R-10.7) should be installed vertically along the slab edge and should extend beneath the outer 20 inches of the slab perimeter. Floor insulation is an important factor that must not be neglected since warm floors contribute to overall comfort and permit comfortable living at a lower indoor winter temperature.

Windows and Doors

Windows

Windows and doors are usually the greatest source of heat loss and gain. Window area should not exceed 8 percent of the floor area and should consist of a prime window with its frame caulked in place. Storm windows or insulated glass are recommended. Storm windows are preferred since they further reduce air filtration.

Glass area should be protected by roof overhang, window coating, or other acceptable shading method that will reduce the effect of solar radiation by at least 70 percent during the cooling season.

Exterior Doors

1 3/4-inch steel clad doors with foamed urethane core and magnetic weather stripping are recommended (R-13.5). This reduces heat loss and gain through

doors up to 90 percent over conventional designs. Weather stripped thresholds, caulked in place with base flashing, are recommended.

Equipment (Heating and Cooling)

A central heating and cooling system is recommended with ducts located below the ceiling insulation and above a 7-foot high, furred down ceiling in the hallway to eliminate duct loss. For further energy savings, a modern heat pump system is recommended for most applications. A heat pump requires about half as much electrical energy as other electric heating systems because it utilizes existing heat in the outside air, giving maximum energy benefit for your energy dollar.

Humidity Control

A mechanical dehumidifier is recommended for adequate moisture removal. Small and medium sized homes with properly installed vapor barriers usually have no need for a humidifier to add moisture to the air, but one might be desirable in larger homes.

An electrostatic air filter is recommended, especially for smaller homes, because of the greatly reduced intake of outside air.

Vapor Barriers

A continuous vapor barrier should be provided on the heated side of all insulation to prevent moisture from entering and condensing in the insulation, with resulting mildew and deterioration. Either polyethylene of a six mil thickness or a foil-backing behind the gypsum board are recommended for this purpose. The Kraft paper backing usually found on batt insulation is not considered adequate because it does not form a continuous barrier. A six mil polyethylene vapor barrier must be installed beneath all concrete slab floors.

For crawl space construction two polyethelyne barriers are required: one above the subfloor and one on the earth surface beneath the house as a ground cover.

Attic Ventilators

Power roof ventilators are recommended for all installation - with soffit vents spaced evenly along the eaves to provide 80 square inches of free area for each 100 CFM of fan capacity. Power ventilators should be sized to change the air in the attic space 10 times per hour and should be controlled by a thermostat set to turn on at 100 degrees F. and off at 85 degrees F.

"THE ARKANSAS STORY"

The first two sections of this CONSERVATION part of the Alternative Energy Curriculum deal with the implementation of energy saving techniques mainly in new construction. "The Arkansas Story" is particularly important because it is a method of providing a positive alternative to the energy wasteful home designs of the past. The major drawback to the implementation and acceptance of this information or method is the fact that many "old timers" in the construction and housing industry refuse to change. They can point to no reason other than it is different from what they have used in the past and that they have little or no interest in this new and vital technique of home construction.

"The Arkansas Story" is a story about the design, construction, and testing of an energy efficient home. Development was done entirely in Arkansas.

With the competitive desire and need to keep the cost of homes as low as possible, the home building industry has had little incentive, until recently, to inform prospective customers of the fact that heating and cooling savings for the life of the mortgage exceed the cost of preventing much of the energy loss. While low construction cost is still important, reduced energy consumption

and costs have become essential to the nation and a marketable home benefit for the builder.

Today, in many parts of the country, utility costs are exceeding the home owner's monthly mortgage payments. The home buying public is well aware of the importance of a well insulated energy conserving home.

Home owners and renters are already protesting loudly at today's increases in energy costs which at this point average 40-80 percent above 1973. If homes continue to be built to conventional pre-energy crisis low insulation standards and energy costs continue rising beyond 1985, it is questionable if home owners will be able to afford their home heating and cooling costs by the turn of the century. The energy conserving home provides the answer.

The designer of the "Arkansas Home" is Mr. Frank Holtzclaw. Mr. Holtzclaw is a retired HUD construction analyst. He worked in conjunction with Arkansas Power and Light. The "Arkansas Home" design is the culmination of 12 years of testing. In this design, Holtzclaw designed a house that used less lumber and that could be built in less time. It is claimed this construction in Little Rock costs no more than the conventional single story, slab floor home construction it was designed to replace.

Special Note: Mr. Harry Tschumi is also responsible for the design of the "Arkansas Home."

Standards for the Arkansas Energy Conservation Home in Little Rock

General

2" x 6" studs (utility grade, No. 3 or better), 24" on centers, single plates with joints centered on studs and joined with tie plates. Modified truss, 24" on centers centered over studs and attached to the stud with anchors at each end. A scissor truss with extended legs is necessary for a cathedral ceiling. Interior, non-load bearing walls may be 2" x 3", or 24" o.c. without headers over doorways. Sheathing must extend to the same height as attic

insulation.

Insulation

R-38 in attic. Two layers of R-19 unfaced batts manufactured to stated R-value. The attic insulation is extended the full thickness until it reaches the outer sheathing.

Unfaced R-19 batts between 6" wall studs on 24" centers. Wiring routed along sole plate through raceway (V slit at bottom of studs) to avoid interfering with proper insulation installation.

Caulking should be used under the sole plate. Unfaced R-19 beneath the crawl space is a necessary addition. R-10 closed cell urethane foam is used around the perimeter of slab floors and as a thermal break separating porches, patio and garages from conditioned space.

Vapor Barrier

6 mil polyethylene is used beneath the slab, or on conditioned side covering the entire floor space above the insulation for crawl space floors. 6 mil polyethylene or foil-backed gypsum board on the entire ceiling and exterior walls on conditioned side of insulation. Include 6 mil polyethylene ground cover for crawl space floors.

Windows and Exterior Doors

a. Window and door area must not exceed 10 percent of total floor area, by outside measurement, nor 15 percent for individual rooms.
b. Windows must have insulated glass or storm windows. Storm windows in preference or in addition to insulating glass or even more desirable wood frame windows and storm windows.
c. Urethane core, steel clad door with magnetic weather strip must be included.

d. Storm doors are required for doors rated less than R-7 or if windows are cut into insulated steel doors.

e. As much as possible, avoid placing window areas in the south or west walls.

f. Try to avoid placing concrete patios and walkways close to the house on the south and west where they may reflect heat despite overhang.

Attic Ventilation

Use a thermostatically controlled power ventilator to give 10 air changes per hour mounted near the center and peak of the roof. Evenly spaced eave vents are used to provide 80 square inches of free area for each 100 CFM of fan capacity. Ridge and gable vents are not considered as equal in Arkansas.

Fireplaces

Fireplaces, if installed, shall be entirely within the conditioned space, have a tight fitting damper and glass screen, and have an outside air source introduced at the hearth. The exterior of the fireplace should be insulated.

Air Ducts

Rectangular metal ducts should be installed within the conditioned space, preferably lined with 1" thick duct liners. Pre-fabricated glass fiber ducts may also be used.

All joints and seams in sheet metal and in vapor barriers shall be taped or cemented.

Other Equipment

Heat pump of electric furnace and airconditioner,

Electrostatic air filter,

Humidifier,

Dehumidifier,

Catwalk above insulation for access to attic space,

Centralized plumbing core near water heater location.

Note: no equipment is to be located in the attic space.

Summary

The Arkansas energy conservation home in Little Rock is built with 6" stud walls, 24" on center. This allows for compression of 6" of fiberglass insulation in the 5½" walls. These homes have 9 foot exterior walls because of the use of a modified truss that allows for the placement of 12" fiberglass insulation in the attic. The inside walls remain at 8 feet.

One major difference in wall construction is that the total window area of the house must be restricted to 8% of the gross living area. In addition, these must be insulated double pane windows or single windows with a storm window. Plywood headers replace 2" x 8"'s allowing more space for insulation. The trusses, also 24" on center, are required to rest on the top plate directly over the top of the studs. Metal perforated tie plates are used at wood joints and back-up clips are used to hold the gypsum board. A polyethylene vapor barrier completely covers the inside face of both studs and insulation. Foil backed gypsum may be used instead to provide the barrier. Electrical outlets are caulked or taped to the gypsum board.

Note: 2" x 4" walls with 3½" insulation and 1" styrofoam do not meet the Arkansas objective.

Crawl Space and Slab Insulation

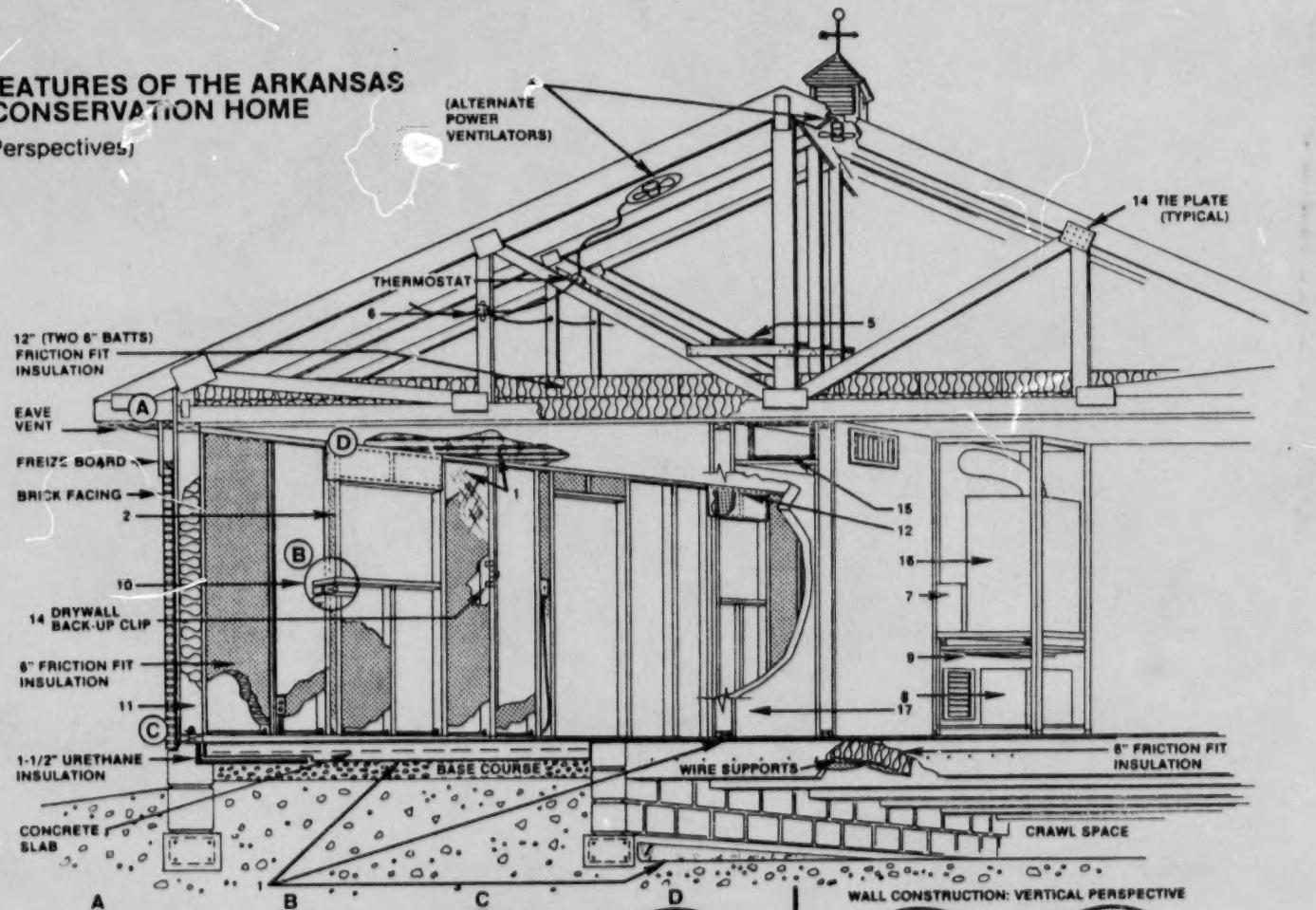
Keep in mind that heat flows to colder surfaces or areas. Where walls and ceilings are well insulated, the heat will be attracted to and dissipated by the coldest surface even if this is the floor.

Since people are quickly chilled if their feet feel cold, this tends to make them desire a higher thermostat setting. For both energy management and comfort, the floor areas must be maintained as close as possible to room temperature. It has been found in Little Rock that this requires 6" of insulation over the crawl space or a minimum of 1½" of closed cell polyurethane rigid foam insulation around the perimeter of the slab. In crawl space construction the finish grade must be fully covered with a moisture barrier and since another vapor barrier is installed above the floor insulation, the crawl space must be ventilated.

On following page, see the DESIGN FEATURES OF THE ARKANSAS ENERGY CONSERVATION HOME.

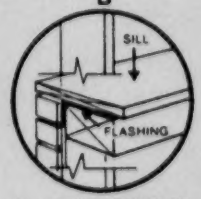
DESIGN FEATURES OF THE ARKANSAS ENERGY CONSERVATION HOME

(Illustrative Perspectives)

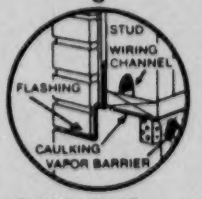


WALL CONSTRUCTION: VERTICAL PERSPECTIVE

DETAIL AT THE EAVES CEILING INSULATION EXTENDS OVER STUD WALL TO SHEATHING.



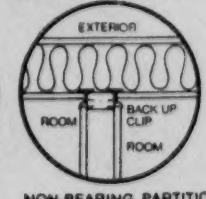
WINDOW FLASHING AS LAID OVER WINDOW FRAME DRAINING INTO BRICK MOTAR JOINT.



BASE FLASHING EXTENDS FROM BEHIND SHEATHING INTO COURSE OF BRICKS.

1/2 INCH PLYWOOD HEADER GLUED AND NAILED, IN PLACE OF SHEATHING, OVER WINDOW.

POSITIONING OF CORNER STUDS TO ALLOW THE INSULATION TO FILL CORNER.



NON-BEARING PARTITION JOINS THE EXTERIOR WALL

REPRINTED FROM "ENERGY SAVING HOMES - THE ARKANSAS STORY"

INTRODUCTION

This third section of the CONSERVATION curriculum deals with how to make existing homes more energy efficient. We cannot deny the fact that the greater percentage of homes today do not employ energy conservation measures even to a small degree.

The best place to start your plan for a home energy conservation program is a comfortable chair. Remember that a good job requires much consideration and very careful planning.

Since we live in the South, we have a longer cooling season than the northernportion of the United States. We use our airconditioning much more. Our winters are not always mild, so we have to plan for a winter that is often quite harsh. Arkansans freeze in the winter and burn up in the summer. These conditions place a large demand on our energy supplies all year long.

Consider what type of fuels your home uses. Could an electric furnace be supplemented or replaced by a cast iron woodburning stove? The same goes for a gas (propane, butane or natural gas) heating system. In the summer time, could the home be served by planting shade trees, installing an attic fan or applying solar (mirror) films to windows that face south? Consider a careful implementation of positive suggestions as a result of using the "Home Energy Check List," that appears later in this section. This list can be used as a guideline to set up a first line defense against wasteful home energy expenditures.

In most circumstances, the battle to make a home more energy efficient will not be nearly as expensive as never making the attempt. The cost of weather stripping and caulking is paid back in the form of savings on the energy bill.

The initial phase of this section begins with a discussion of weather stripping and caulking.

WEATHER STRIPPING AND CAULKING

All homes leak air. In the summer it leaks cooled air to the outside and lets hot air in. In the winter it leaks warm air to the outside and lets cold air in. These leaks cost you money. This process of unwanted air migration is called infiltration. Air that you want to leave the home either by opening a window or turning on a fan is called ventilation.

About one half of the air in an average insulated house (with caulked windows, storm doors and windows) will change every hour. Air manages to enter even a modern well built home to change the air completely every two hours. The point is that 40-70% of your heating costs could be for heating the outside air that enters the home.

Wind is the primary cause of infiltration. When the wind blows against your house, it creates a strong positive pressure that can force air into your home. The use of vapor barriers cuts down on positive air infiltration. As the wind passes over the home, it tends to draw air away by suction from the downwind side of the house. This creates a negative pressure on the outside of the house, drawing air from the inside to the outside. Trees and shrubbery can act as windbreaks to reduce the force of the wind against your house. The rule for the placement of the windbreak is that it should be located at a distance of not more than five times the height of your home.

Note: the two worst offenders for infiltration are windows and fireplaces.

Weather Stripping

Weather stripping is usually cheap to buy. It pays in the long run to buy the highest quality materials the first time you do the job. Cheaper materials are no bargain if they have to be repalced a year or two after installation.

Basic Varieties of Weather Stripping

FLAT METAL STRIPS are bent so that one edge may be nailed against the window frame while the other edge is held by tension against the window itself.

TUBULAR GASKETS are made of rubber or vinyl in the form of a hollow or solid tube with a flat strip for nailing.

F E L T (aluminum-reinforced and non-reinforced) is very inexpensive but should not be used in a high wear area.

FOAM S T R I P S are made of many different materials (vinyl, neoprene sponge and polyurethane). This material has a low initial cost and short life expectancy.

Weather Stripping Door Bottoms

SWEEPS are made of flexible plastic, vinyl, or other materials. It is so-called because of the sweeping action it makes when the door is opened.

THRESHOLD GASKET mounted on floor presses against the bottom of the door when it is closed.

DOOR BOTTOM GASKET presses against the bottom of the door when it is closed.

METAL DOORS (foam filled) and magnetic vinyl gaskets. The principal advantage of the metal door is increased security and more effective weather stripping.

Caulking

Caulking is used as a permanent seal where two different parts of the house meet or where outside air penetrates a house through a crack or hole.

C a ulking should be applied:

1. Around window frames where they meet wall siding.
2. Around door frames where they meet wall siding.
3. At corners formed by two walls with siding.
4. Where the house meets the foundation.
5. Where wires and pipes enter the house.
6. Where chimneys or masonry meet siding.
7. Where aluminum storm windows meet window frames.

There are basically five types of caulking for your home:

1. Oil based - poor life expectancy.
2. Vinyl based - good.
3. Butyl rubber - very good.
4. Acrylic latex - very good.
5. Silicone rubber - best.

Tips for doing a satisfactory caulking job:

1. Never caulk when the temperature is below 45 degrees F.
2. Remove excess dirt from the area to be caulked.
3. Reduce the amount of caulking needed when cracks are large, fill them in with oakum.
4. Push caulking in to improve adhesion.
5. Buy plenty of caulk.

INSULATION

One of the best ways to conserve energy usage in the home is to put as much as 12 inches of fiberglass in the attic. You can find out how much insulation your home has by going up into the attic. Your local lumber dealer or insulation contractor will be happy to discuss any improvements that you feel might be necessary. If you can do the job of installing the insulation yourself, you may be able to save as much as 50% of the cost of the job.

If you live in an older home (10 years or more) you may or may not have insulation in the ceiling. Some World War II vintage homes do not have insulation in the ceiling, the walls or under the floor over the crawl space.

Types of Insulation

Of the many varieties of insulation on the market, most fall into one of four basic groups:

1. Blankets or Batts
2. Loose Fill
3. Rigid
4. Blown

Blankets or Batts

These types are the kind which are most familiar to people. The insulation material is usually either fiberglass or mineral wool, which is much like fiberglass except that it is made from melted rock instead of glass. The insulation comes in two widths, either in long rolls (called blankets) which must be cut to fit the length of space, or in precut lengths called batts. Fiberglass and mineral wool have the advantage of being fire and vermin proof, moderate in cost, and easy to install.

Loose Fill

This material comes in bags which can simply be poured in place. The most common materials for loose fill insulation are vermiculite and perlite granules. Both are made from rock.

This type of insulation can be poured into spaces in concrete blocks or into the spaces behind walls in new construction but it is most commonly used in attics. Because there is no cutting, fitting, or stapling, this can be one of the fastest and easiest do-it-yourself insulating jobs. The materials are fireproof and will not deteriorate from moisture. They can settle, however, especially in walls.

Rigid

Rigid insulation comes in precut boards which are used primarily during new construction but which may be installed to add insulation to an existing basement masonry wall.

Blown

Blown insulation is one of the most common methods of adding insulation to an existing home. It is also the most expensive alternative in most cases. This type of insulation is applied using air pressure and therefore requires an experienced contractor.

Four types of blown insulation -

- Mineral fiber - fiberglass and rock wool
- Cellulose - recycled paper treated with a fire retardant chemical
- Urea foam (formaldehyde based)-injected into walls, may shrink
- Urethane foam - injected into walls, best available, will not shrink

Where to Insulate

Start by insulating your home's attic. The choice of insulation for your attic will depend on the construction of your home and the present and future use of the attic. Most building codes require that attics be insulated to R-19 but many utility companies are recommending it be as high as R-38.

An unfinished attic without a floor - you may use blankets, batts, loose fill, or urethane foam. The insulation should extend above the ceiling joists.

Warning!!! If you are adding insulation to an attic that already has some you should use only unfaced insulation. Failure to do so might result in condensation in the insulation and the reduction of the thermal protection capacity.

An unfinished attic with a floor - the best place for the installation of insulation, if you do not finish the attic, is to blow the insulation under the floor. Your choice of material will depend on the R-value you want.

Finished attics - will require the removal of a portion of the interior building material, so that the necessary spaces can receive the insulation material.

Walls - insulating walls of an existing house is an expensive job. In most cases a contractor is hired to drill holes in the walls and fill the cavities with blown insulation.

Floors, basements and crawl spaces - there are basically four different types of spaces that can occur under a house and there is a slightly different strategy for insulating each.

a. Concrete slab - in this case there is little you can do to add insulation. If the slab is colder than you like, check to see if there are any drafts due to infiltration around the slab. Adding a pad and a carpet is one way of insulating the top of the floor.

b. Crawl space - consider insulating a crawl space only if there is enough room to do the work and if there is no insulation there now. The cheapest and easiest method is to cover the walls around the crawl space with blanket insulation.

c. Open crawl space or unheated basement - if your house is raised on piers, you have to insulate between the floor joists of the heated room. If you have an unheated basement you can insulate it the same way you do a regular crawl space: by putting insulation under the floor joists then tacking chicken wire up to protect it.

d. Full basement - if you have a full basement, you will probably want some heat from the house to escape in the direction of the basement. This will protect pipes from freezing in the winter. In this case, insulate the basement walls instead of the ceiling.

HEATING AND COOLING EQUIPMENT

There are basically two ways you can save money on your heating and cooling equipment:

A. Use it less.

B. Use it effectively.

Furnace

Some special equipment to help you in your effort to conserve on your heating bill might be a:

1. Resistor-type control with timer - this unit is a small heating coil which is mounted on the wall just below the thermostat. When the resistor is on, it heats up and "fools" the thermostat into thinking that the room is warmer than it is. This runs on a timer.

2. Clock thermostat - this thermostat would most likely replace your present thermostat. This thermostat gives you more precise control. It is possible to turn the thermostat down while you are away or in bed at night.

Ducts

The greatest controllable loss from a forced hot-air heating system is from uninsulated leaking ducts. Use of uninsulated ducts in crawl space and attics is quite common. Instruct your heating and air-conditioning contractor to make sure that the ducts are well sealed. This may be accomplished by filling each joint between sections of duct work with heat-resistant caulking and or using duct tape.

Air-conditioning

Air-conditioning is very expensive and in the near future likely to become cost prohibitive. Few consumers realize that in the United States electric rates are increased during the summer. In order to handle added air-conditioning loads, most utilities must expand their generating capacity in the summer. This extra capacity is very costly and the cost is passed on to everyone, especially to users of air-conditioning, in the form of higher summertime rates.

There are generally two means of air-conditioning.

1. Window units - these units give you the option of cooling only a few rooms, thereby possibly reducing your bill 50% to 80% below what you would spend on operating a whole-house system.

2. Central air - this is the most expensive means of cooling your home that you can own and operate. This system cools the entire home. It even cools rooms that are not in use if the owner does not remember to close off the air vent leading to the room.

Note: You will save about 3% of your air-conditioning bill for each degree you turn up your thermostat in summer.

Air Filters

The air filters in the central air-conditioning system of the home need to be replaced every two to three months. These panels are located at the return air vents in the heater closet where the fan is located.

Types of air filters -

a. Coated aluminum mesh filters are made of several layers of split aluminum which form baffles that bounce air back and forth against the sides of the filter. When the filter is sprayed with a tacky adhesive, it is very effective in removing even the smallest particles from the air.

b. Standard fiberglass filters remove one-tenth of the particles in room air.

c. Plasticized fiber filters have many "pockets" which catch air pollutants more effectively than plain glass fibers can.

Fireplaces

The common fireplace is a very inefficient way to heat with wood. A wood stove is much more efficient.

If the family decides to install a fireplace, insist on a tight fitting damper. A fireplace with a loose damper or none at all is like leaving a window open at night during the winter.

If the fireplace does not have a vent to the outside for an outside air source when it is being used, you may have to open a window in the room to allow in sufficient air to keep the fire burning. Depending on the size, a fire can draw from 3,000 to 15,000 cubic feet of air (one to five roomfuls) up the chimney every hour.

In return, the fireplace will radiate 3 to 10 percent of the heat of the fire back into the room. It is, therefore, one of the poorest sources of heat you can have in your home.

Fireplace efficiency can be improved by:

1. Use of a firebox unit that has an outside air source.
2. Glass doors.
3. Tight fitting damper.
4. Convective grate.
5. Fireplace mirror.

A PPLIANCES

The BIG TEN list of energy using appliances include water heater, dishwasher, electric lights, clothes washer, clothes dryer, refrigerator, freezer, ranges and ovens, microwave, and television. We will take up only the first three.

Water Heater

The water heater is one appliance which, besides the airconditioner, is the biggest energy-using appliance in the home. The electric water heater is the most expensive type to operate. The owner of an electric water heater and an electric furnace will find an ever increasing electric bill each month in his mail box. Natural gas is the most efficient, and at this point, the least expensive fuel for use in the home.

You can cut down on the hot water bill by installing a water heater insulation jacket. This helps to maintain the unit's efficiency. You can also turn the water heater down from 140 degrees to 120 degrees. It is necessary to leave the thermostat at 140 degrees only if you have a dishwasher that does not have its own water pre-heating element.

The only disadvantage to this lower setting is that all members of the family may not be able to take a hot bath or shower one right after the other. This situation may require household rescheduling.

Dishwasher

If you have a dishwasher, it is one of the major hot water consumers in your home. An electric dishwasher consumers about 25 gallons of hot water in a normal washing cycle. In many homes a daily wash is done without the dishwasher being full. Washing only full loads can lead to a 30 percent reduction in the hot water used.

A dishwasher has a drying cycle at the end of the normal wash cycle which consumes additional electricity. Enough electricity is used, in fact, to put it on the TOP TEN energy users list for this consumption alone.

Electric Lights

A fluorescent lamp provides three to four times more light than an incandescent lamp using the same amount of electricity. In addition, fluorescent lights last seven to ten times longer than incandescent lights. It also emits 75 percent less heat which reduces air conditioning loads. The only major drawback to fluorescent lights is that they need special fixtures.

Rules for making the most economical use of one's lighting:

1. Turn lights off when not in use.
2. Light the task instead of the room.
3. Reduce ornamental lighting and use automatic timers to control night lighting.
4. Use sunlight as much as possible.

Special Note: When purchasing an appliance that uses electricity compare the Energy Efficiency Ratio. This information is required by federal law and is there to help you make a decision about which appliance would best fit your budget.

SECTION III (EXISTING CONSTRUCTION) INFORMATION

HOME ENERGY CHECK LIST

	Yes	No
1. Is the house free of cold drafts?	___	___
2. Are all window frames caulked and is the putty around the glass in good shape?	___	___
3. Are all door bottoms properly weather stripped?	___	___
4. Are exterior house doors closed quickly after use?	___	___
5. Are there storm windows (if you live in a cool climate)?	___	___
6. Are draperies and shades closed at night and on cloudy, windy days during the heating season?	___	___
7. Do draperies fit snugly around windows?	___	___
8. Are draperies insulated?	___	___
9. Do all windows have draperies, shades, or other coverings that may be opened to admit sunlight in the heating season and closed on sunny days during the cooling season?	___	___
10. Are plants located around the house to provide a break against the wind and to shade against unwanted sun?	___	___
11. Is natural ventilation used as much as possible?	___	___
12. Is the attic ventilated or is there an attic fan for use in the summer?	___	___
13. Do you know how much insulation is in the attic?	___	___
14. Is the attic insulated to R-38 (equal to 12 inches of fiberglass)?	___	___
15. Are the walls insulated?	___	___
16. Do floors exposed to unheated or cooled air have insulation?	___	___
17. Is the thermostat set at 68 degrees F. or below during the heating season and turned back to 55 degrees F. at night?	___	___
18. Are air ducts insulated in unheated and uncooled spaces?	___	___
19. Are air filters clean and are draperies and furniture located so they do not obstruct heating, air-conditioning or ventilation?	___	___

SECTION III (EXISTING CONSTRUCTION) INFORMATION

		Yes	No
20.	Is the furnace checked each year and is the efficiency reported to you?	—	—
21.	Does the fireplace have a damper and is it closed when the fireplace is not in use?	—	—
22.	Does the fireplace have glass doors?	—	—
23.	Does the fireplace have its own source of outside air?	—	—
24.	Is the thermostat set at 78 degrees or above during the cooling season?	—	—
25.	Is the air-conditioning equipment properly sized for the cooling required?	—	—
26.	Does the air-conditioning have a high efficiency ratio?	—	—
27.	Is an outside air-conditioning unit located on the shady side of the house?	—	—
28.	Is the water heater insulated and set back to 120 degrees or less?	—	—
29.	Do family members take short showers or use only small amounts of water for tub baths?	—	—
30.	Are clothes washed in cold or warm water whenever possible and rinsed in cold water?	—	—
31.	Is the dishwasher used only when there is a full load?	—	—
32.	Is the frost on the refrigerator and freezer less than ¼" thick?	—	—
33.	Is the oven used to bake more than one food at a time?	—	—
34.	Are there fluorescent lights when appropriate?	—	—
35.	Do family members dress more warmly indoors during cool weather to avoid mechanical heating?	—	—
36.	Is less cooking done during the summer in order to help keep the kitchen cool and reduce the air-conditioning load?	—	—
37.	Do family members sleep with warm comforters instead of heating bedrooms and/or the whole house?	—	—
38.	Are meals eaten at home regularly?	—	—
39.	Do foods that are in season and grown locally form a large part of meals at home?	—	—
40.	Has the house's potential for using solar energy been carefully judged?	—	—

SECTION III (EXISTING CONSTRUCTION)

	INFORMATION	Yes	No.
41.	Does part of the roof face south?	—	—
42.	Is part of the house exposed to the sun all day?	—	—
43.	Is the heated swimming pool covered at night?	—	—
44.	Do family members use car pools or public transportation to get to work or school?	—	—
45.	Has the family's car been tuned up in the last six months?	—	—
46.	Are errands in town done in one longer trip instead of several short ones?	—	—
47.	Have drivers in the family read the starting instructions in the owner's manual?	—	—
48.	Are heavy items such as golf clubs, snow tires, and tools removed from the car trunk when not needed?	—	—
49.	Do you know what it costs to operate the car per mile?	—	—
50.	Does the car get over 20 miles per gallon?	—	—
	Total:	—	—

YES answers to 43 or more questions show that your household is truly conserving energy.

YES answers to 37-42 questions show that your household is energy conscious but not yet dedicated to conserving energy.

YES answers to 30-36 questions show that your household is wasting energy but with minor changes could become energy conserving.

YES answers to 23-29 questions show that your household is wasting energy and need to make an all-out effort to improve.

YES answers to fewer than 23 questions show that your household is making an effort to waste energy and should consider the long-range and immediate effects.

GLOSSARY

AIR CHANGES - expression of ventilation rate in terms of room or building volume. Usually air changes per hour.

AIR STRATIFICATION - warm air rises to high points within a building because it is lighter and more bouyant than cooler air. Air stratification is usually undesirable in winter. During the summer, the warm air can be vented, including natural ventilation through the building, thus reducing need for air-conditioning.

AMBIENT - ambient temperature is the temperature in the surrounding space.

BUILDING LOAD - the rate of heat loss from the building at steady state conditions when the indoor and outdoor temperatures are at their selected design levels.

CONDENSATION - water obtained by changing the state of water vapor from a gas to a liquid usually by cooling.

CONDUCTION - conduction is the transfer of thermal energy through materials, from the warmest spot to the coolest spot - the larger the temperature difference, the faster the energy movement.

DAMPERS - a device used to vary the volume of air passing through an air outlet, inlet, or duct.

DEGREE DAY - the difference between the median temperature of any day and 65 degrees F. when the median temperature is less than 65 degrees F.

ECONOMIZER CYCLE - a method of operating a ventilation system to reduce refrigeration load. Whenever the outdoor air conditions are more favorable than return air conditions, outdoor air intake is increased.

ENERGY REQUIREMENT - the total yearly energy used by a building to maintain the selected inside design conditions under the dynamic impact of a typical year's climate.

EVAPORATION - when water and air are in contact and the relative humidity of the air is less than 100 percent, water will evaporate. The energy required to evaporate the water reduces the air temperature. The added moisture raises the humidity.

GLAZING - a material that is highly transparent to solar radiation. It is used to admit and trap solar heat. Glazing, usually glass or plastic, is an essential element of most passive solar designs.

HEAT GAIN - it is that amount of heat gained by a space from all sources including people, lights, machines, sunshine, etc. The total heat gain represents the amount of heat that need not be provided to a space to maintain indoor comfort conditions.

HEAT LOSS - the total heat lost by the building structure when the outdoor temperature is lower than desired indoor temperature. It represents the amount of heat that must be provided to a space to maintain indoor comfort conditions.

HEAT PUMP - a refrigeration machine possessing the capability of reversing the flow so that its output can be either heating or cooling. When used for heating, it extracts heat from a low temperature source at the point where it can be used.

INFILTRATION - the process by which outdoor air leaks into a building by natural forces through cracks around doors and windows, etc.

INSULATION - a material with a high resistance to heat flow. It is used to reduce conductive heat loss from buildings in cold climates and reduce heat gain in warm climates.

LIFE CYCLE COST - the cost of equipment over its entire life including operating and maintenance costs.

NATURAL CONVECTION - air movement resulting from differing temperatures of adjacent air masses. It is used to transport thermal energy, without the use of fans, from one location to another. This is most easily accomplished when the warmest location and source of heat is lower in elevation than cooler locations requiring heat.

REFLECTORS - these increase the amount of solar radiation striking a surface or entering through a window. Movable reflectors can also be positioned to shade a building during the summer.

RELATIVE HUMIDITY - a measure indicating the moisture content of the air.

R-VALUE - the resistance to heat flow expressed in units of square feet-hour degree F. temperature difference per Btu.

SHADING - keeping the sun off the building and off the windows at appropriate times of the year is essential for keeping the building cool. Shading mechanisms include vegetation, portions of the building itself, auxiliary devices such as overhangs, and insulation in the form of drapes that shade and shutters that insulate.

THERMAL MASS - heavy materials within buildings, such as concrete, stone, and water, which aid in the storage of thermal energy for both heating and cooling. They can temper and time delay the effect of fluctuating inputs of energy, such as solar energy.

THERMAL RADIATION - thermal radiation is a major energy transfer means inside a building. This radiation is similar to light, but it has such a long wave length it is not visible.

TON OF REFRIGERATION - a means of expressing cooling capacity. One ton equals 12,000 Btu per hour cooling.

VAPOR BARRIER - a moisture impervious layer designed to prevent moisture migration.

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INSTRUCTIONAL MATERIALS

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III. BIBLIOGRAPHY

LECTURE OUTLINE

Section I (Passive Solar) - Information

I. INTRODUCTION

- Many experts feel that in the very near future a major shift will be undertaken to change from the current techniques of home construction to those that incorporate facets of passive solar design.
- It is a fact that most housing designs today run the risk of being energy obsolete and overly costly long before the homes have reached their life usefulness termination point.
- It is important that a student of today learn about passive solar design because many will be faced with the necessity of using it in the future.

A. Definition of Passive Solar Design

1. A formal definition of passive solar design is the following:

   Passive solar designs are methods for heating or cooling buildings or for heating domestic water in which thermal energy flows by natural means (i.e., without pumps or fans).

2. "Active" systems have moving parts and power requirements of the fans and pumps.

B. Advantages and Disadvantages

1. Advantages -

   a. Inherent simplicity of passive systems which generally results in greater reliability, lower material costs, and longer lifetimes.

   b. Savings of fossil fuels.

   c. Decrease in balance of payment deficit.

   d. Beneficial environmental impact.

2. Disadvantages -

   a. Increased construction costs

   b. Problems of making the underground portion of the house water tight.

   c. Lack of public education.

   d. Buyer wariness.

II. FIVE BASIC SYSTEM TYPES

A. Direct Gain
B. Convective Loops
C. Thermal Storage Walls
D. Thermal Storage Roofs
E. Attached Sunspaces

A. Direct Gain - Fig. A-1

Direct gain systems use solar radiation that enters through glass or plastic directly into the space to be heated. Nearly all the solar radiation entering the room is immediately converted to heat.

B. Convective Loops - Fig. A-2

As the air in the space between the glass and the blackened absorber surface is heated, it expands and becomes lighter, rises through the collector, and flows into the room through a vent at the top. Cooled room air, drawn into the collector through another vent at the base of the wall, replaces the warmed air leaving the collector.

C. Thermal Storage Walls - Fig. A-3

The thermal energy entering the building is stored in a wall between the outer glass sheathing and the space to be heated. There are two types of thermal storage:

. Masonry storage walls
. Water drum storage

D. Thermal Storage Roofs - Fig. A-4

This system uses roof ponds of water stored in large clear vinyl bags that are supported on a black, waterproof liner. Solar radiation is absorbed both by the water and the black liner. This heat is then conducted through the ceiling, in contact with the bags, to the space below.

E. Attached Sunspaces - Fig. A-5

This system uses a greenhouse to provide heat and indoor garden space to the house occupants. It is located on the southern side of the home.

F. Advantages and Disadvantages of the Five Basic System Types

1. Direct gain -

a. Advantages:

. Glazing is a relatively inexpensive form of solar collector and is widely available.

- The overall system can be one of the least expensive means of solar heat.
- Easiest to build.
- Glazing allows for heating, lighting and visual access to the outside.

b. Disadvantages:

- Glare during the day and loss of privacy during the night.
- Ultraviolet radiation in the sunlight will degrade fabrics and photographs.
- The means to provide insulation at night for this form of energy collection can be expensive and awkward.

2. Convective loops -

a. Advantages:

- Convective loops provide one of the least expensive ways to solar heat.
- Convective loops are easily adapted to existing buildings.

b. Disadvantages:

- Careful engineering and construction are required to ensure proper air flow.
- Convective loops provide poor storage mediums.

3. Thermal storage walls -

a. Advantages:

- Glare and ultraviolet degradation of fabrics are not a problem.
- Temperature swings in the living space are lower than with direct gain or convective loop systems.

b. Disadvantages:

- Two south walls, a glazed wall, and a mass wall, are needed.
- The mass wall occupies valuable space within the building.

4. Thermal storage roofs -

   a. Advantages:

      . Heating and cooling effects are more uniformly distributed throughout the building.

      . Temperature swings in the building are small.

   b. Disadvantages:

      . Structural support for the heavy mass can be costly.

      . The heavy weight of the thermal mass may be dangerous in earthquake prone areas.

5. Attached sunspaces -

   a. Advantages:

      . Temperature swings in adjacent living spaces are small.

      . These additions provide space for growing food and other plants.

   b. Disadvantages:

      . Thermal performance varies from one design to another.

      . Commercial quality construction is costly.

LECTURE OUTLINE

Section II (Building Design) - Information

I. INTRODUCTION

- How energy efficient is your home?
- The basic principle behind the design of a new home will be simple: the house must gather as much energy as possible from its environment and then make use of every bit of energy it has gathered.

A. Think Small

1. Thinking "small" is the basic rule for energy efficiency.
2. Combine rooms wherever possible.

B. Use Efficient Shapes

1. You should enclose as much space as possible with the least amount of wall and roof exposure to the weather.
2. The ideal shape for a home is a dome. It encloses the greatest amount of space with the least amount of exterior side.
3. Adding a second floor can double your living space without an increase in roof area.

C. Wise Placement - Fig. B-1

1. The way your home sits on its land should be determined by the sun and wind.
2. The main window area should face south (a roof overhang is necessary).

D. Build Underground

1. A home built underground can take advantage of the fact that the ground temperature a few feet below the surface will remain about 50 degrees F. all year long.

   Note: It is not easy to waterproof a house that's built underground. Much effort will be necessary to insure no water seepage.

E. Take Advantage of Landscaping - Fig. B-1

1. Using trees and shrubs for sunscreens is a cheap, natural way to temper your environment.
2. Trees can cool your home even without shading it directly. Their shade prevents the earth from absorbing heat, their transpiration

process works like evaporative cooling.

3. A grouping of decidous trees can lower air temperature around your home by as much as 15 degrees during the summertime.

II. INSULATION

. One of the primary concerns of the home owner should be the amount of insulation that he has in his home.

. The higher the R-Value, the more efficient the insulation.

A. Recommendations (by the Arkansas Power and Light Co.)

1. Exterior walls: R-19 insulation carefully fitted between 2" x 6" studs, on center (6" batts of fiberglass or equivalent).

2. Ceilings: two batts of R-19 6" insulation for a total resistance of R-38.

3. Floors: R-19 batt insulation is recommended for floors over crawl space or basements.

4. For slab floors: 1½" urethane board (R-10.7) should be installed vertically along the slab edge and should extend beneath the outer 20 inches of the perimeter.

B. Windows and Doors

1. Windows and doors are usually the greatest source of heat loss and heat gain.

2. Window area should not exceed 8 percent of the floor area and should consist of a prime window with its frame caulked in place.

3. Glass area should be protected by a roof overhang, window coating, or other acceptable shading method that will reduce the effect of solar radiation.

4. Exterior doors should be 1 3/4" steel clad, with foamed urethane core and magnetic weather stripping are recommended. This reduces heat loss and heat gain through the doors up to 90 percent over conventional designs.

5. Weather stripped thresholds, caulked in place with base flashing are recommended.

C. Equipment (Heating and Cooling)

1. A heat pump is recommended for most applications.

2. A central heating and cooling system is recommended with ducts located below the ceiling insulation and above a 7-foot high, furred down ceiling in the hallway to eliminate duct loss.

D. Humidity Control

1. A mechanical dehumidifier is recommended for adequate moisture removal.

2. A humidifier is required in some homes if the occupants wake with very dry throats or there is a static electricity buildup in the carpet.

E. Vapor Barriers

1. A continuous vapor barrier should be provided on the heated side of all insulation to prevent moisture from entering and condensing in the insulation, with resulting mildew and deterioration.

2. Either polyethylene of a 6 mil thickness or a foil-backing behind the gypsum board are recommended for this purpose.

3. Kraft paper backing usually found on batt insulation is not considered adequate because it does not form a continuous barrier.

4. A 6 mil polyethylene vapor barrier must be installed beneath all concrete slab floors.

5. For crawl space construction two polyethylene barriers are required: one above the subfloor and one on the earth surface beneath the house as a ground cover.

F. Attic Ventilators

1. Power roof ventilators are recommended for all installations.

2. Soffit vents should be spaced evenly along the eaves to provide 80 square inches of free area for each 100 cubic feet per minute (CFM) of fan capacity.

3. Power ventilators should be sized to change the air in the attic space 10 times per hour and should be controlled by a thermostat set to turn on at 100 degrees F. and off at 85 degrees F.

III. "THE ARKANSAS STORY"

"The Arkansas Story" is particularly important because it is a method of providing a positive alternative to the energy wasteful home designs of the past.

- Many "old timers" in the construction industry feel that they are too old to change their ways, thus causing a slowdown in the implementation of these positive building methods.
- "The Arkansas Story" is a story about the design, construction, and testing of an energy efficient home.
- Development was done entirely in Arkansas.
- Today in many parts of the country, utility costs are exceeding the home owner's monthly mortgage payments.
- The designer of the "Arkansas Home" is Mr. Frank Holtzclaw.
- It is claimed that this construction in Little Rock costs no more than the conventional single story, slab floor home construction it was designed to replace.

A. Standards for the Arkansas Energy Conservation Home in Little Rock

1. General - Fig. B-2

   a. 2" x 6" studs (utility grade, or better), 24" on centers, single plates with joints centered on studs and joined with tie plates.

   b. Modified truss, 24" on center, centered over studs and attached to the stud with anchors at each end.

   c. Scissor truss with extended legs is necessary for a cathedral ceiling.

   d. Interior, non-load bearing walls may be 2" x 3", or 24" on center without headers over doorways.

   e. Sheathing must extend to the same height as attic insulation.

2. Insulation - Fig. B-3

   a. R-38 in the attic.

   b. The attic insulation is extended the full thickness until it reaches the outer sheathing.

   c. Unfaced R-19 batts between 6" studs on 24" centers.

   d. Wiring routed along the sole plate through a V cut raceway at the bottom of the stud.

   e. Caulking should be used under the sole plate.

   Note: Oil based caulking should never be used here because it will break down after two years and the home owner will be unable to replace it.

f. Unfaced R-19 beneath the crawl space is a necessary addition.

g. R-10 closed cell urethane foam is used around the perimeter of slab floors and as a thermal break separating porches, patio, and garages from conditioned space.

3. Vapor Barrier -

a. 6 mil polyethylene is used beneath the slab, or on conditioned side covering the entire floor space above the insulation for crawl space floors.

b. Use 6 mil polyethylene or foil-backed gypsum board on the entire ceiling and exterior walls on conditioned side of insulation.

c. Include 6 mil polyethylene ground cover for crawl space floors.

4. Windows and Exterior Doors -

a. Window and door area must not exceed 10 percent of the total floor area, by outside measurement, nor 15 percent for individual rooms.

b. Windows must have insulated glass or storm windows.

c. Urethane core, steel clad door with magnetic weather strip must be included.

d. Storm doors are required for doors rated less than R-7 or if windows are cut into insulated steel doors.

e. Avoid placing window area on the south side of the building if the plan does not call for an overhang that will cut down on direct gain.

5. Attic Ventilation -

a. Use a thermostatically controlled power ventilator to give 10 air changes per hour.

b. Evenly spaced eave vents are used to provide 80 square inches of free area for each 100 CFM of fan capacity.

6. Fireplaces - Fig. B-4

a. If a fireplace is installed, it should be entirely within the conditioned space, have a tight fitting damper and glass screen.

b. The firebox should have an outside air source introduced at the hearth.

c. The exterior of the fireplace should be insulated.

7. Air Ducts -

a. Rectangular metal ducts should be installed within the conditioned space. These ducts should be lined with 1" thick duct liner.

b. All joints and seams in the sheet metal and vapor barrier shall be taped or cemented.

8. Other Equipment

a. Heat pump, electrostatic air filter, humidifier, and dehumidifier if necessary.

b. No equipment should be located in the attic.

c. Installation of a catwalk above the insulation for access to attic space should be provided.

d. Centralized plumbing core near water heater location.

B. Summary - Fig. B-5, B-6

1. 2" x 6" walls.

2. 9 foot exterior walls with modified truss, allows for the placement of 12 inches of fiberglass insulation in the attic.

3. The interior walls remain at 8 feet.

4. Window area must be restricted to 8 percent of the gross living area.

5. Windows must be insulated glass or wood with storm windows.

6. Plywood headers replace 2" x 8"'s allowing more space for insulation.

7. Trusses are placed 24" on center directly on the top plate located right over the top of the stud.

8. M e t a l tie plates and back-up clips are used to hold the gypsum board.

9. A polyethylene vapor barrier completely covers the inside face of both studs and insulation.

10. Electrical outlets are caulked or taped to the gypsum board.

Crawl Space and Slab Insulation -

- For both energy management and comfort, the floor areas must be maintained as close as possible to room temperature. This, it has been found in Little Rock, requires 6 inches of insulation over the crawl space or a minimum of 1½" of closed cell polyurethane rigid foam insulation around the perimeter of the slab.

- Crawl space must be ventilated.

LECTURE OUTLINE

Section III (Existing Construction) - Information

I. INTRODUCTION

A. The emphasis of this curriculum is to lay the basic foundation for an individual to learn and apply what he has learned to better his life situation.

B. The best place to start your plan for a home energy conservation program is a comfortable chair.

C. A good job requires much consideration and very careful planning.

D. Use the "Home Energy Check List". This list can be used as a guideline to set up a first line defense against wasteful home energy expenditure.

E. In most circumstances, the battle to make a home more energy efficient will not be nearly as expensive as never making the attempt.

II. WEATHER STRIPPING AND CAULKING

. All homes leak air.

. These leaks cost you money.

. Infiltration is the process of unwanted air migration into the home.

. Ventilation is letting air into or out of the structure because of choosing to open a window or door.

. About one half of the air in an average insulated house will change every hour.

. Air manages to enter even a modern well built home to change the air completely every two hours.

. Wind is the primary cause of infiltration.

. The use of a vapor barrier cuts down on positive air infiltration.

A. Weather Stripping

1. It pays in the long run to buy the highest quality weather stripping materials the first time you do the job.

2. Cheap materials are no bargain if they have to be replaced a year or two after installation.

Basic varieties of weather stripping

Flat metal strip: are bent so that one edge may be nailed against the window frame while the other edge is held by tension against the window itself.

Tubular gasket: are made of rubber or vinyl in the form of a hollow or solid tube with a flat strip for nailing.

F e l t : is very inexpensive but should not be used in high wear areas.

Foam s t r i p: is made from many different materials. This material has a low initial cost and short life expectancy.

Weater stripping door bottoms

Sweeps: are made of flexible plastic, vinyl, or other materials. It is so called because of the sweeping action it makes when the door is opened.

Threshold gasket mounted on the floor: presses against the bottom of the door when it is closed.

Door bottom gasket: presses against the bottom of the door when it is closed.

Metal doors (foam filled): offer more security and higher energy efficiency due to the foamed interior and magnetic weather stripping.

B. Caulking

Caulking is used as a permanent seal where two different parts of the house meet or where outside air penetrates a house through a crack or hole.

Caulking should be applied:

1. Around windows.
2. Around door frames.
3. At corners formed by two walls with siding.
4. Where the house meets the foundation.
5. Where wires and pipes enter the house.
6. Where chimneys and masonry meet siding.
7. Where aluminum storm windows meet window frames.

There are basically five types of caulking for your home:

1. Oil based - poor life expectancy.
2. Vinylbased - good.

3. Butyl rubber - very good.
4. Acrylic latex - very good.
5. Silicone rubber - best (expensive).

Tips for doing a satisfactory caulking job:

1. Never caulk when the temperature is below 45 degrees F.
2. Remove excess dirt from the area to be caulked.
3. Fill large cracks with oakum before caulking to reduce the amount of caulking used.
4. Push caulking in to improve adhesion.
5. Buy plenty of caulk.

III. INSULATION

. One of the best ways to conserve energy usage in the home is to put as much as 12" of fiberglass insulation in the attic.

. If you do the job of installation yourself, you may be able to save as much as 50 percent of the cost of the job.

A. Types of Insulation

Of the many varieties of insulation on the market, most fall into one of four basic groups:

1. Blankets or batts
2. Loose fill
3. Rigid
4. Blown

1. Blankets or batts -

These are the kind most familiar to people. The insulation material is usually either fiberglass or mineral wool. The insulation comes in two widths, either in long rolls (called blankets) which must be cut to fit, or in precut lengths (called batts). Fiberglass and mineral wool have the advantage of being fire and vermin proof, moderate in cost, and easy to install.

2. Loose fill -

These materials come in bags which can simply be poured in place. The most common materials for loose fill insulation are vermiculite and perlite granules. Both are made from rock.

3. Rigid -

Comes in precut boards which are used primarily during new construction but which may be installed to add insulation to an existing basement masonry wall.

4. Blown

Blown insulation is one of the most common methods of adding insulation to an existing home. This type of insulation requires an experienced contractor.

Four types of blown insulation:

a. Mineral fiber - fiberglass or rock wool.
b. Cellulose - - recycled paper treated with a fire retardant chemical.
c. Urea foam (formaldehyde based) - this product is injected into walls from the outside of the structure. This product may shrink inside the walls.
d. Urethane foam - this product is injected into the walls usually from the outside. This is the best type of insulation on the market that you can get for your home. This product does not shrink.

B. Where to Insulate

1. Start by insulating the attic.
2. Most building codes require that attics be insulated to R-19 but many utility companies are recommending insulation of as high as R-38.
3. If you have an unfinished attic without a floor, use blankets, batts, loose fill, or urethane foam. Use only unfaced insulation when putting down any additional insulation.
4. Use blown insulation under the floor if you are going to insulate an unfinished attic with a floor.
5. You will have to remove portions of the flooring to install the blown insulation necessary for finished attics.
6. Most of the time the walls of a home are insulated by drilling holes into the exterior walls and filling t h e cavities with blown insulation. These directions apply only to those homes that have been built with no insulation in the walls.
7. If a home has already been constructed and the owner wishes to add insulation to the slab, the only thing that can be done is to put carpet down.
8. Homes with crawl spaces must utilize a method of applying blanket insulation on the interior walls under the house.
9. Put insulation under the floor joists when insulating an open crawl space. Use chicken wire to hold the blanket insulation in place.

10. If the home has a full basement, one must protect the pipes from freezing. This is done by insulating the basement walls instead of the basement ceiling.

IV. HEATING AND COOLING EQUIPMENT

There are basically two ways to save money on your heating and cooling equipment:

. Use it less.

. Use it effectively.

A. Furnace

Some special equipment to help you in your effort to conserve on your heating bill -

1. Resistor type control with timer - this unit is a small heating coil which is mounted on the wall just below the thermostat. When the resistor is on, it heats up and "fools" the thermostat into thinking that the room is warmer than it is. This unit runs on a timer.

2. Clock thermostat -this thermostat would most likely replace your present thermostat. This thermostat gives you more precise control. With multiple setbacks, it is possible to turn the thermostat down while you are away or in bed at night.

B. Ducts

1. The greatest controllable loss from a forced hot air heating system is from uninsulated leaking ducts.

2. Use of uninsulated ducts in crawl space and attics is quite common.

3. Ducts should be well sealed by filling each joint between sections of duct work with heat-resistant caulking and or duct tape.

C. Air-conditioning

1. Air-conditioning is very expensive and in the near future likely to become cost prohibitive.

2. There are generally two types of airconditioners:

   a. Window unit.
   b. Central air-conditioning.

3. You will save about 3% of your air-conditioning bill for each degree you turn up your thermostat in summer.

4. Air filter - the air filters in a central air-conditioning system of the home need to be replaced every two or three months when in use.

   Types of air filters:

   a. coated aluminum mesh
   b. standard fiberglass
   c. plasticized fiber filters

D. Fireplaces

1. The common fireplace is a very inefficient way to heat with wood. A wood stove is more efficient.

2. A fireplace with a loose damper or none at all is like leaving a window open at night during the winter.

3. Depending on the size, a fire can draw from 3,000 to 15,000 cubic feet of air (one to five roomfuls) up the chimney every hour.

4. The fireplace will radiate 3 to 10 percent of the heat of the fire back into the room.

5. A fireplace is one of the poorest sources of heat you can have in your home.

6. A fireplace efficiency can be improved by:

   a. Use of firebox unit that has an outside air source.
   b. Use of glass doors.
   c. Making sure that the damper is tight fitting.
   d. Use of a convective grate.
   e. Use of a fireplace mirror.

V. APPLIANCES

The BIG TEN list of energy using appliances:

A. Water Heater
B. Dishwasher
C. Electric Lights
D. Clothes Washer
E. Clothes Dryer
F. Refrigerator
G. Freezer
H. Ranges and Ovens
I. Microwave
J. Television

A. Water Heater

1. The water heater is one appliance which, besides the airconditioner, is the biggest energy using appliance in the home.

2. Natural gas is the most efficient and least expensive fuel for use in the home as well as for heating water.

3. It is recommended that the home owner use a water heater insulation jacket that wraps around the heater and prevents any large escape of useful radiant heat that comes from the water heater.

4. You may be able to save a large amount of money by turning your water heater down from 140 degrees to 120 degrees if you don't have a dishwasher.

B. Dishwasher

1. A dishwasher is one of the major hot water consumers in your home.

2. Washing only full loads can lead to a 30 percent reduction in the hot water used.

C. Electric Lights

1. A fluorescent lamp provides three to four times more light than an incandescent lamp using the same amount of electricity. In addition, fluorescent lights last 7 to 10 times longer than incandescent lights.

2. Rules for making the most economical use of one's lighting:

   a. Turn lights off when not in use.
   b. Light the task instead of the room.
   c. Reduce ornamental lighting.
   d. Use sunlight as much as possible.

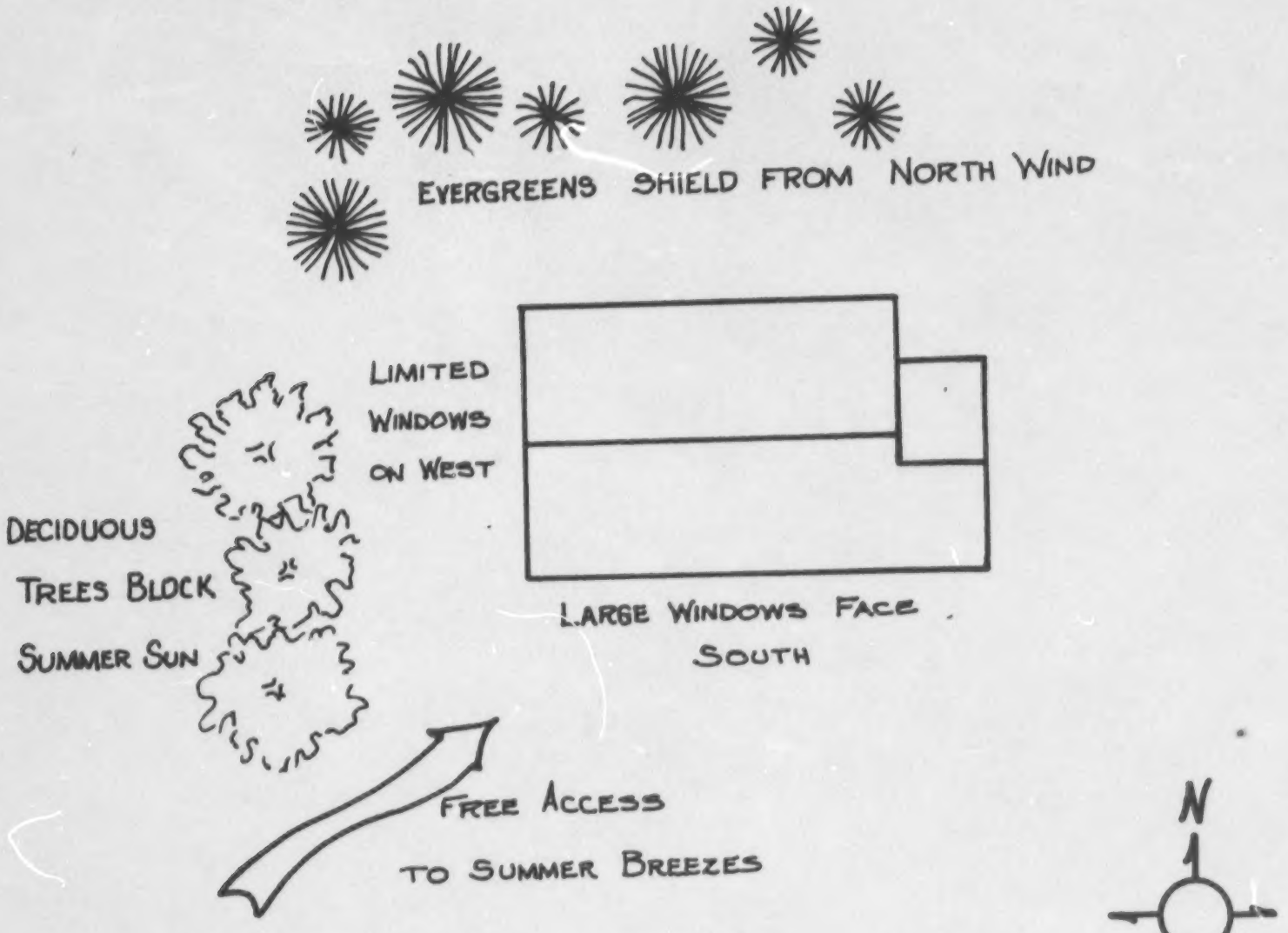
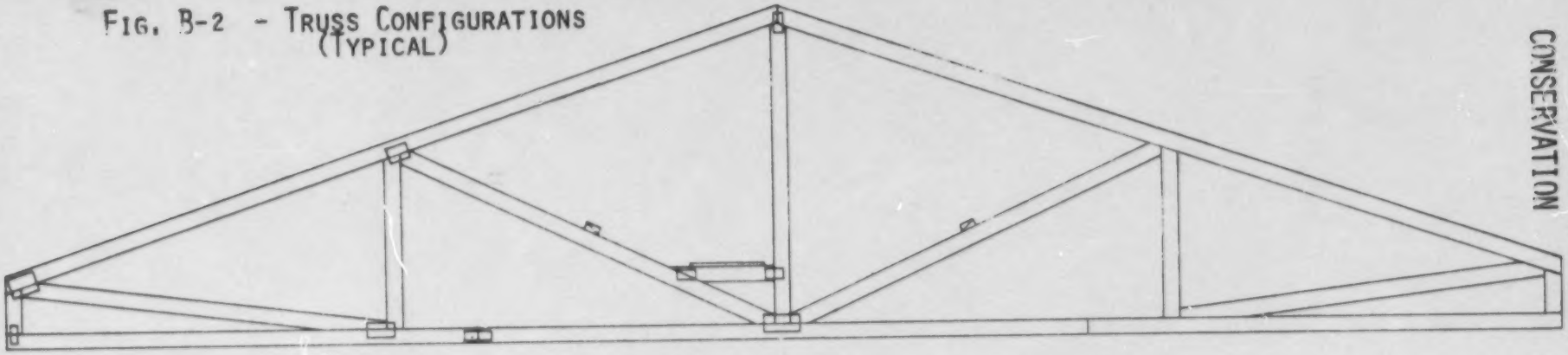
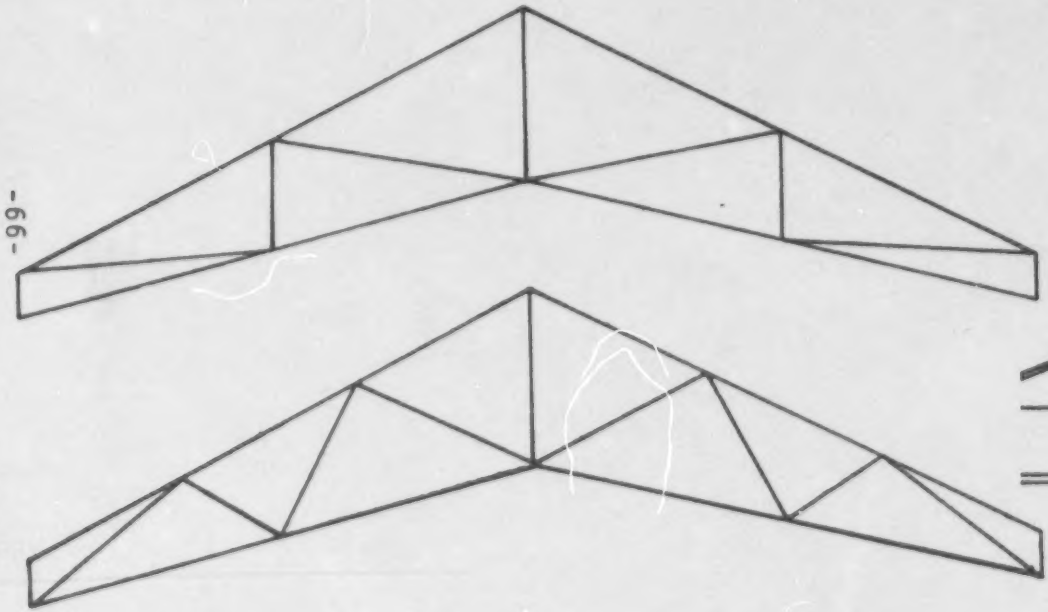
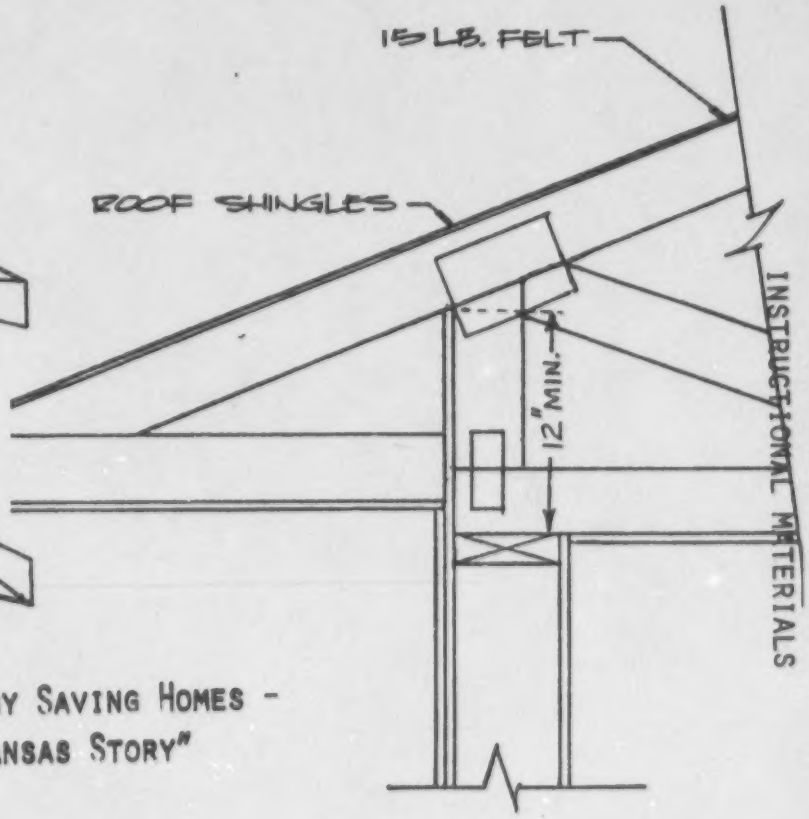


FIG. B-1 - BUILDING PLACEMENT AND LANDSCAPING

FIG. B-2 - TRUSS CONFIGURATIONS (TYPICAL)







Truss Configurations (Typical)

1. Cut all members to bear
2. Center all plates on joints unless otherwise noted
3. Lateral bracing required at midpoint
4. Top cord may be extended according to owner's desire

Cathedral truss configurations courtesy Hydro-Aire Engineering, Inc. For size of framing members and full data consult your local Hydro-Aire truss fabricator listed in the Yellow Pages.

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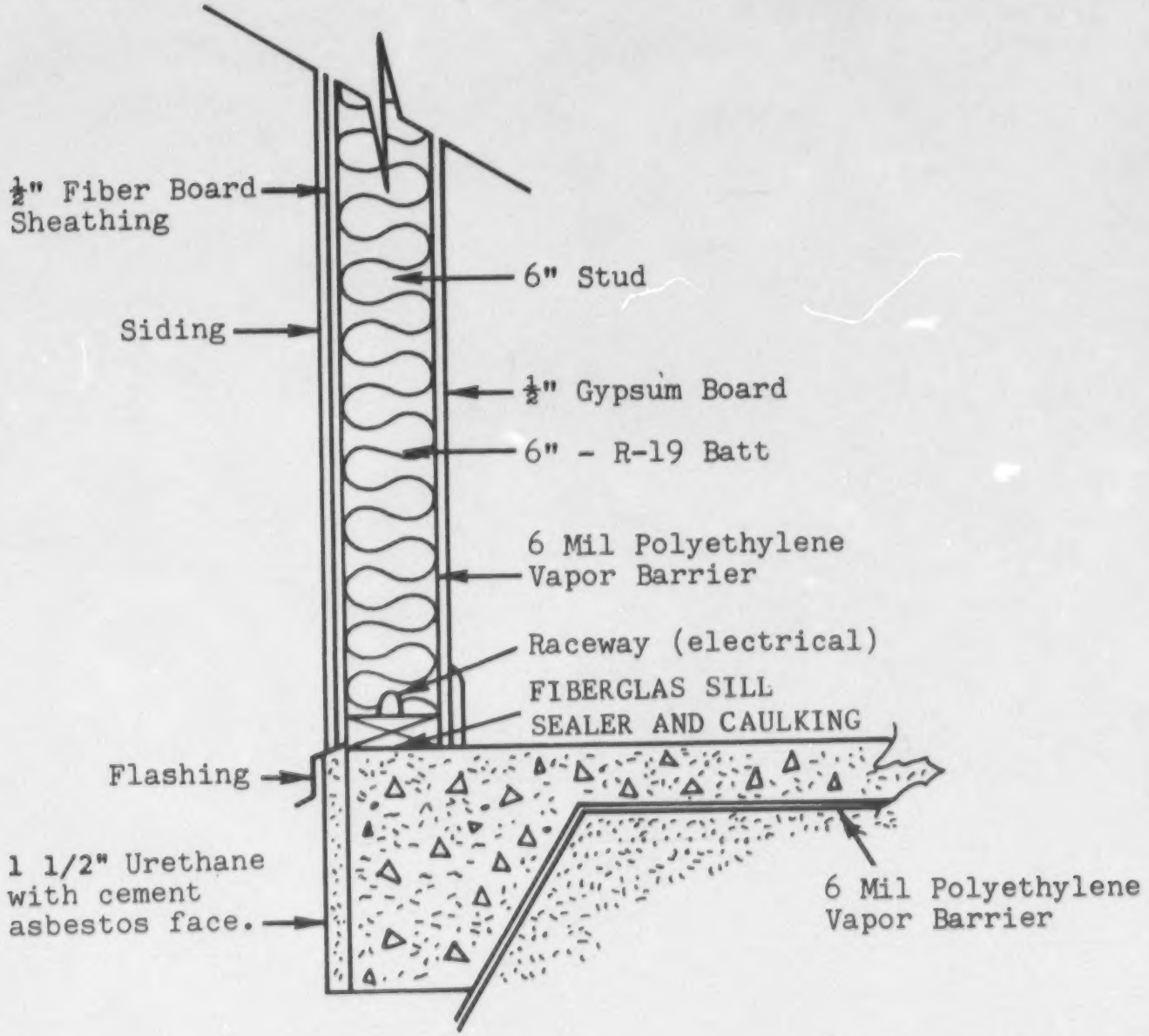
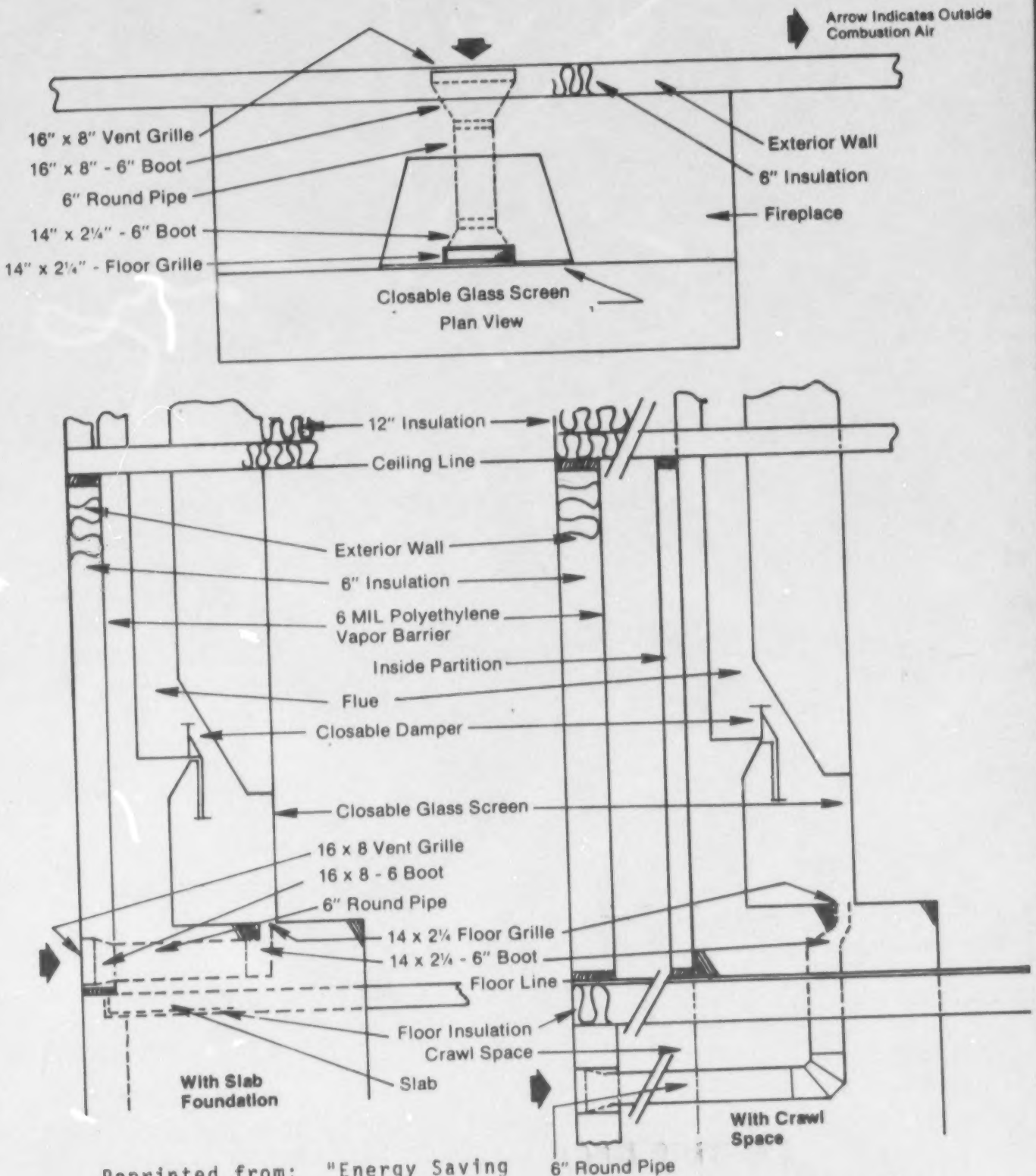


FIG. B-3

WALL SECTION - MONOLITHIC SLAB ENERGY CONSERVATION

REPRINTED FROM: "ENERGY SAVING HOMES - THE ARKANSAS STORY" 4-10-75 F. N. S.

FIG. B -4 - **Fireplace Installation For Super Thermal Homes**



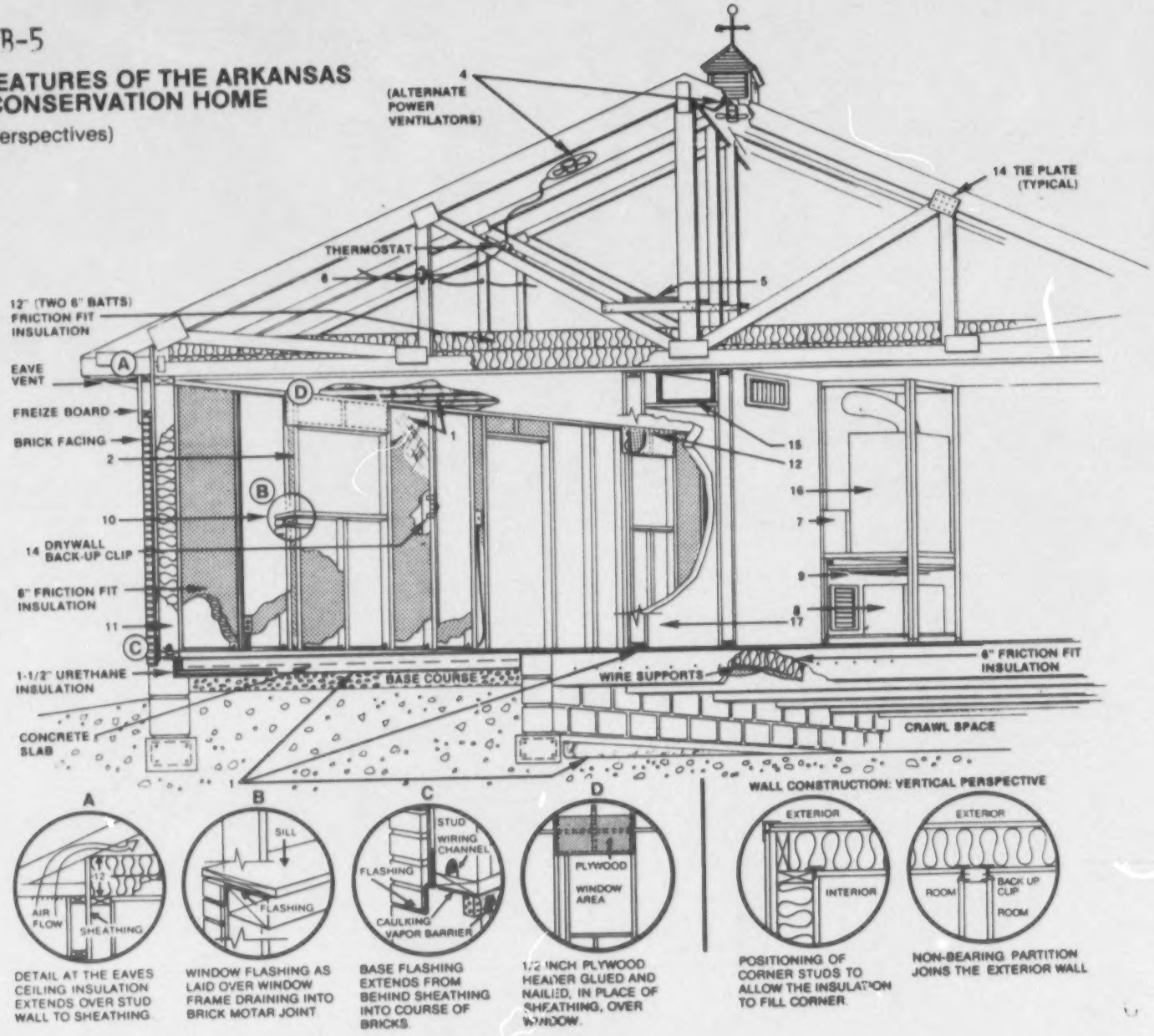
Reprinted from: "Energy Saving Homes - The Arkansas Story"

HAT 4-74

FIG. B-5

DESIGN FEATURES OF THE ARKANSAS ENERGY CONSERVATION HOME

(Illustrative Perspectives)



DETAIL AT THE EAVES CEILING INSULATION EXTENDS OVER STUD WALL TO SHEATHING.

WINDOW FLASHING AS LAID OVER WINDOW FRAME DRAINING INTO BRICK MOTAR JOINT

BASE FLASHING EXTENDS FROM BEHIND SHEATHING INTO COURSE OF BRICKS.

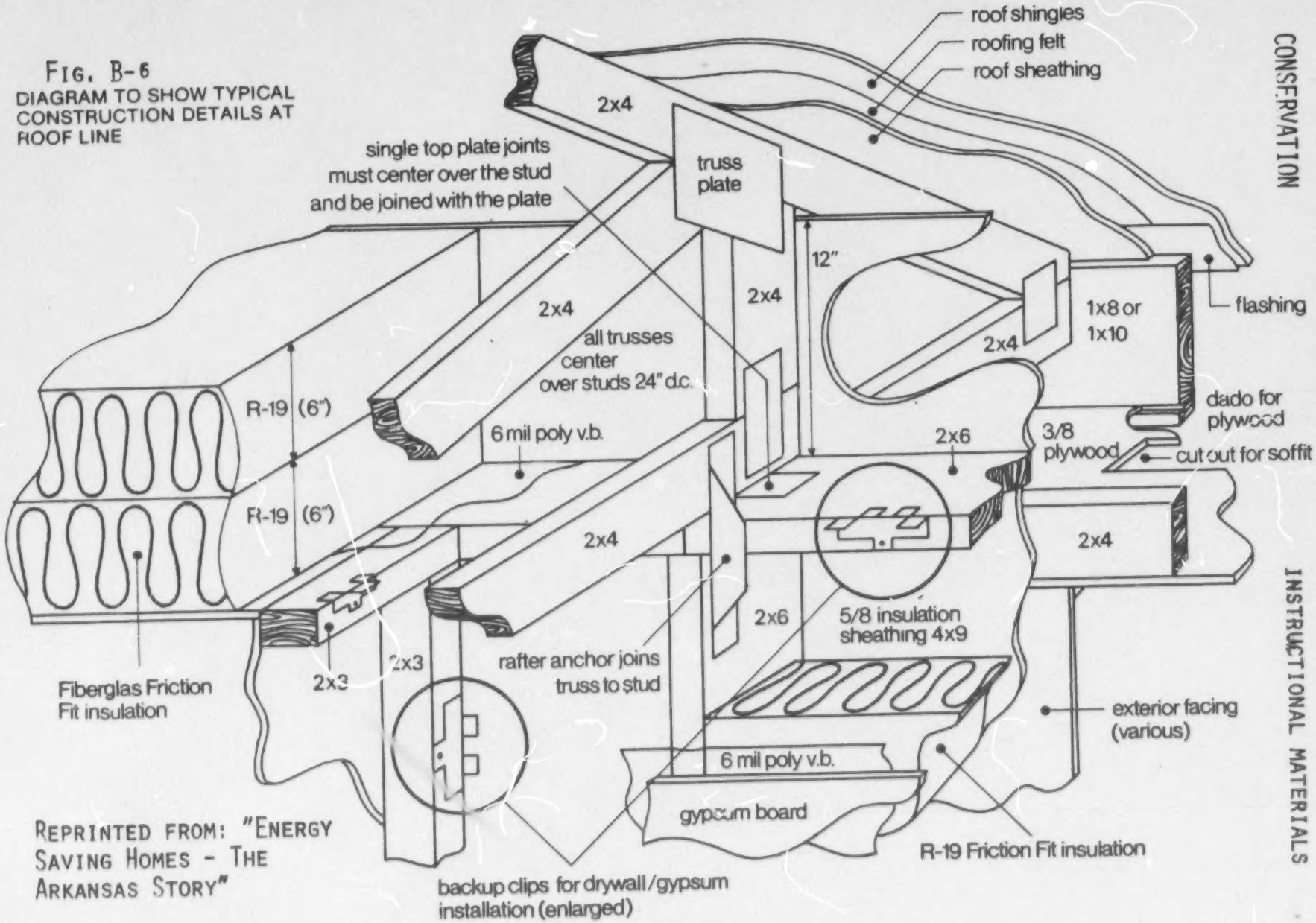
1/2 INCH PLYWOOD HEADER GLUED AND NAILED, IN PLACE OF SHEATHING, OVER WINDOW.

POSITIONING OF CORNER STUDS TO ALLOW THE INSULATION TO FILL CORNER.

NON-BEARING PARTITION JOINS THE EXTERIOR WALL

REPRINTED FROM "ENERGY SAVING HOMES - THE ARKANSAS STORY"

FIG. B-6
DIAGRAM TO SHOW TYPICAL CONSTRUCTION DETAILS AT ROOF LINE



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SECTION I (PASSIVE SOLAR)

1. What is the status of most housing design today?
2. What will be the ultimate outcome of increased energy costs?
3. Why is it important for a student of today to learn about "passive" solar design?
4. What is the definition of "passive solar design"?
5. What are the advantages of "passive solar design"?
6. What are the disadvantages of "passive solar design"?
7. Why is "passive solar energy" cost effective?
8. What are the "societal savings" from "passive solar design"?
9. Know about:
   a. Direct Gain
   b. Convective Loops
   c. Thermal Storage Walls
   d. Thermal Storage Roofs
   e. Attached Sunspaces
10. What are the disadvantages of "direct gain" passive solar design systems?
11. What do many experts in the field feel about "passive solar energy"?
12. What will happen to the homes we are building today - in reference to energy?
13. Are "passive" solar designs reliable?
14. Does a passive solar design favor the environment?
15. Do a lot of people know about "passive solar design"?

SECTION II (Building Design)

1. What is the best way to get a home that can cope with the future?
2. What is the basic principle behind the design of a home?
3. What is the basic rule for energy efficiency?
4. What is the ideal shape for a home?
5. The main window area for a home should face what direction?
6. What is transpiration?
7. What is a cheap way to temper your environment?
8. How much can a group of deciduous trees lower the temperature of your home?
9. What are the primary concerns of the home owner?
10. What are the recommendations made by Arkansas Power and Light for home insulation?
11. What is usually the greatest source of heat loss and heat gain?
12. What is the percent of window area that should not be exceeded on an "energy home"?
13. What is the best type of exterior door?
14. Where should the duct work be located in an "energy home"?
15. What type of heating and cooling equipment is recommended for the energy efficient home?
16. What is a -
    a. humidifier?
    b. dehumidifier?
    c. electrostatic air filter?
17. What is the purpose of a vapor barrier?
18. What is the function of the power attic ventilator?
19. What is the "Arkansas Story" about?

SECTION III (EXISTING CONSTRUCTION)

1. How expensive will it be to wage the battle to make a home more energy efficient?
2. What do all homes have in common?
3. What do the terms VENTILATION and INFILTRATION mean?
4. How often does the air in the average home change?
5. What is the primary cause of infiltration?
6. What will cut down on air infiltration?
7. Where should a windbreak be located?
8. What should you consider about the use and application of weather stripping?
9. What is the function of caulking?
10. What is one of the best ways to conserve energy usage in the home?
11. What type insulation should be added to existing insulation to bring the R-Value up to 38?
12. What is the greatest controllable loss from a forced air heating system?
13. How efficient is a common fireplace?
14. What does the future hold for air-conditioning?
15. What appliances are the biggest users of energy in the home?
16. What are some of the advantages of fluorescent lamp?
17. What are two methods of weather stripping?
18. What are three varieties of weather stripping?
19. Where should you use caulk on the home?
20. What are the different types of caulking?
21. Name four types of insulation.
22. What are two types of air filter?
23. How can you improve fireplace efficiency?

SECTION I (PASSIVE SOLAR)

Assignment No. 1

1. Write a formal definition of "passive solar design". Include 3 advantages and 3 disadvantages in your discussion.

SECTION I (PASSIVE SOLAR)

Assignment No. 2

1. Name and explain five (5) basic system types of passive solar design.

SECTION I (PASSIVE SOLAR)

Assignment No. 3

1. List two (2) advantages and two (2) disadvantages of each of the five (5) basic passive systems.

SECTION I (PASSIVE SOLAR)

Assignment No. 4

1. Make a reasonable representation drawing of each of the five (5) basic passive solar designs.

SECTION II (BUILDING DESIGN)

Assignment No. 1

1. List and explain five (5) guidelines for efficient building design.

SECTION II (BUILDING DESIGN)

Assignment No. 2

1. Answer the following:

   a. What is insulation?
   b. What are the insulation recommendations for new home construction according to A.P. & L. (Arkansas Power and Light)?

      1) Exterior walls?
      2) Ceilings?
      3) Floor?

SECTION II (BUILDING DESIGN)

Assignment No. 3

1. Answer the following questions:

   a. What are the guidelines for window placement in an energy efficient home?
   b. What types of heating and cooling equipment should be used in energy efficient new home construction?
   c. What is the purpose of humidity control?
   d. What is the purpose of a vapor barrier?
   e. Why should you use attic ventilation?

SECTION II (BUILDING DESIGN)

Assignment No. 4

1. Answer the following questions:

   a. What was the Arkansas Story?
   b. Who was the designer of the "Arkansas Energy Efficient Home"?
   c. How long did testing on the "Home" go on?
   d. In which state was the "Arkansas Energy Efficient Home" design first implemented?

SECTION II (BUILDING DESIGN)

Assignment No. 5

1. Summarize the features of the Arkansas Energy Conservation Home in Little Rock.

SECTION III (EXISTING CONSTRUCTION)

Assignment No. 1

1. Use the HOME ENERGY CHECK LIST to evaluate your home and family's energy consumption practices.

   Make a list of all deficiencies that could be corrected in reference to the HOME ENERGY CHECK LIST in your house.

SECTION I (PASSIVE SOLAR)

Assignment No. 1

1. Write a formal definition of "passive solar design". Include 3 advantages and 3 disadvantages in your discussion.

"Passive solar designs" are methods for heating or cooling buildings or for heating domestic water in which thermal energy flows by natural means (i.e., without pumps or fans).

Advantages -

1. No moving parts.
2. Cost effective in long lifetime.
3. Decrease in the national requirement of fossil fuels.

Disadvantages

1. Increased construction costs.
2. Buyer wariness due to radical design.
3. Lack of public education and acceptance.

SECTION I (PASSIVE SOLAR)

Assignment No. 2

1. Name and explain five (5) basic system types of passive solar design.

---

1. Direct Gain - direct gain systems use solar radiation that enters through glass or plastic directly into the space to be heated.

2. Convective Loop - as the air in the space between the glass and blackened absorber surface is heated, it expands and becomes lighter and flows into the top of the room from the collector. Cooled room air replaces the warmed air at the bottom of the collector.

3. Thermal Storage Wall - thermal energy is stored and located between a wall of glass and the space to be heated.

   There are two main types of storage walls:

   a. Masonry
   b. Water storage

4. Thermal Storage Roof - it uses roof ponds of water stored in heavy clear vinyl bags that are supported on a black waterproof liner. The heat is conducted through the ceiling.

5. Attached Sunspace - a greenhouse that is attached to the south side of the home. This building not only provides warmth in the winter but also food all year round.

SECTION I (PASSIVE SOLAR)

Assignment No. 3

1. List two (2) advantages and two (2) disadvantages of each of the five (5) basic passive systems.

---

1. Direct Gain

   Advantages
   a. The overall system is very inexpensive to implement.
   b. Glazing serves multiple purposes.

   Disadvantages
   a. Too much glare during the day.
   b. Ultraviolet degradation of photographs and fabrics.

2. Convective Loops

   Advantages
   a. Inexpensive.
   b. Easily adaptable to existing buildings.

   Disadvantages
   a. Need of careful engineering and construction.
   b. Poor storage medium.

3. Thermal Storage Walls

   Advantages
   a. Glare and fabric degradation are not a problem.
   b. Well advanced state-of-the-art technology.

   Disadvantages
   a. Requires two south walls.
   b. Thermal mass occupies valuable space within the building.

4. Thermal Storage Roofs

   Advantages
   a. Compared with many passive systems, the heating and cooling effects are more uniformly distributed throughout the building.
   b. Temperature swings in the building may be small.

   Disadvantages
   a. Heavy weight of thermal mass above ceiling might be psychologically unacceptable (especially in the earthquake prone areas).
   b. Structural support for the heavy mass can be costly.

SECTION I (PASSIVE SOLAR)

5. Attached Sunspaces

Advantages
a. Temperature swings in the adjacent living spaces are small.
b. They provide space for growing food and other plants.

Disadvantages
a. Thermal performance varies greatly from one design to another, making the performance difficult to predict.
b. Although construction costs can be kept low, commercial quality construction is expensive.

NOTE: Any of the other answers listed in text are of course acceptable.

SECTION I (PASSIVE SOLAR)

Assignment No. 4

1. Make a reasonable representation drawing of each of the five (5) basic passive solar designs.

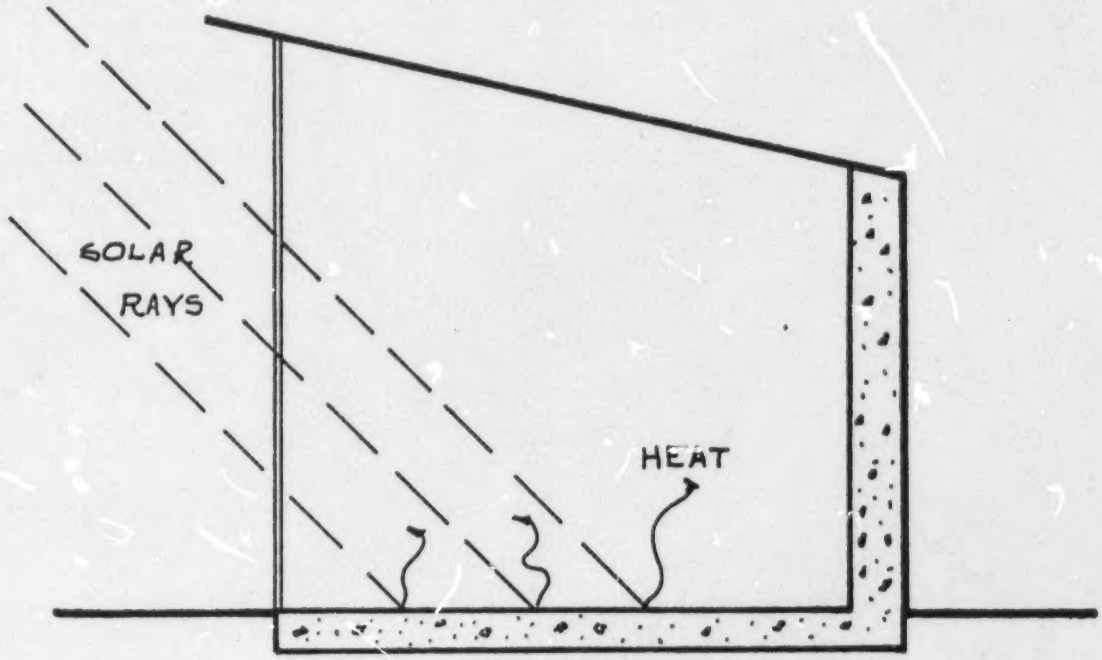

Fig. A-1 - Direct Gain

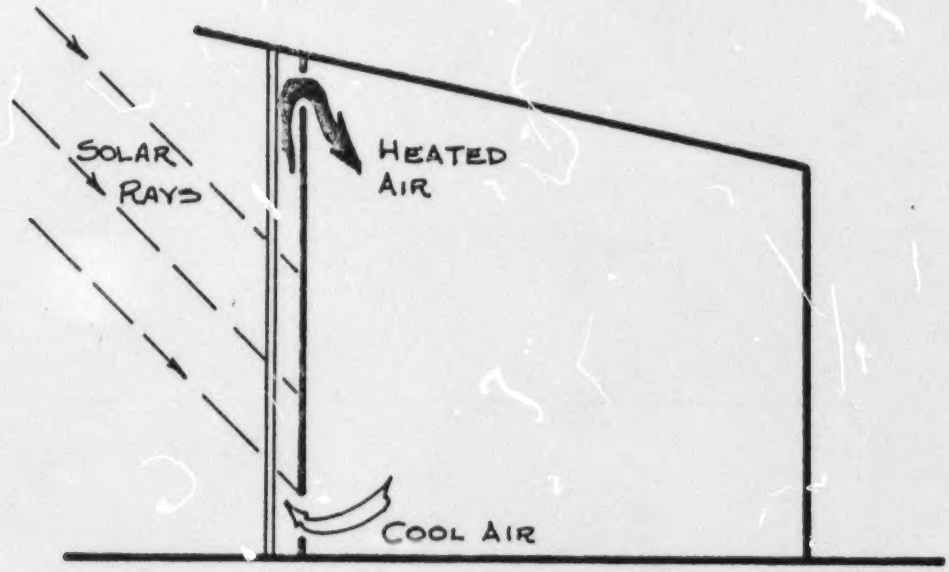

Fig. A-2 - Convective Loop Air Collector

SECTION I (PASSIVE SOLAR)

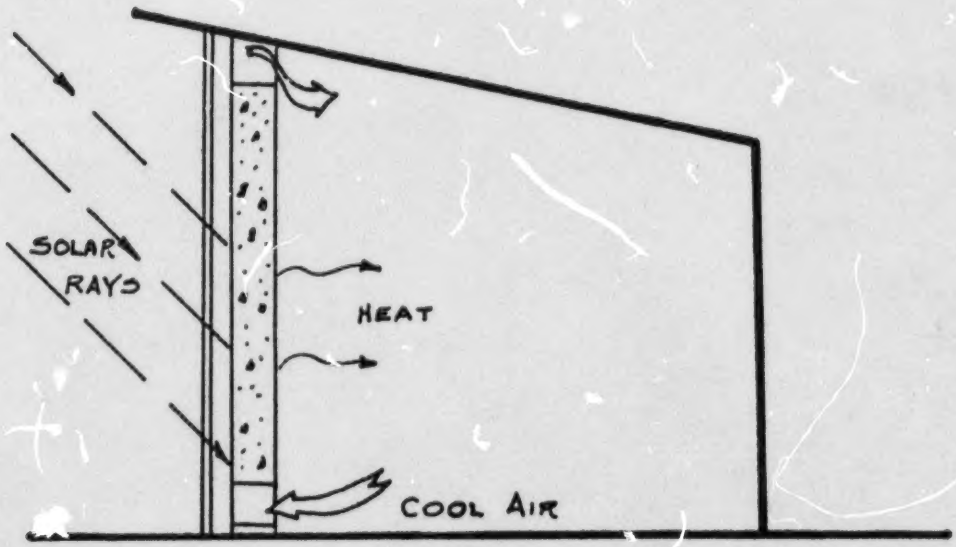

Fig. A-3 - Thermal Storage Wall with Thermocirculation Vents

SECTION I (PASSIVE SOLAR)

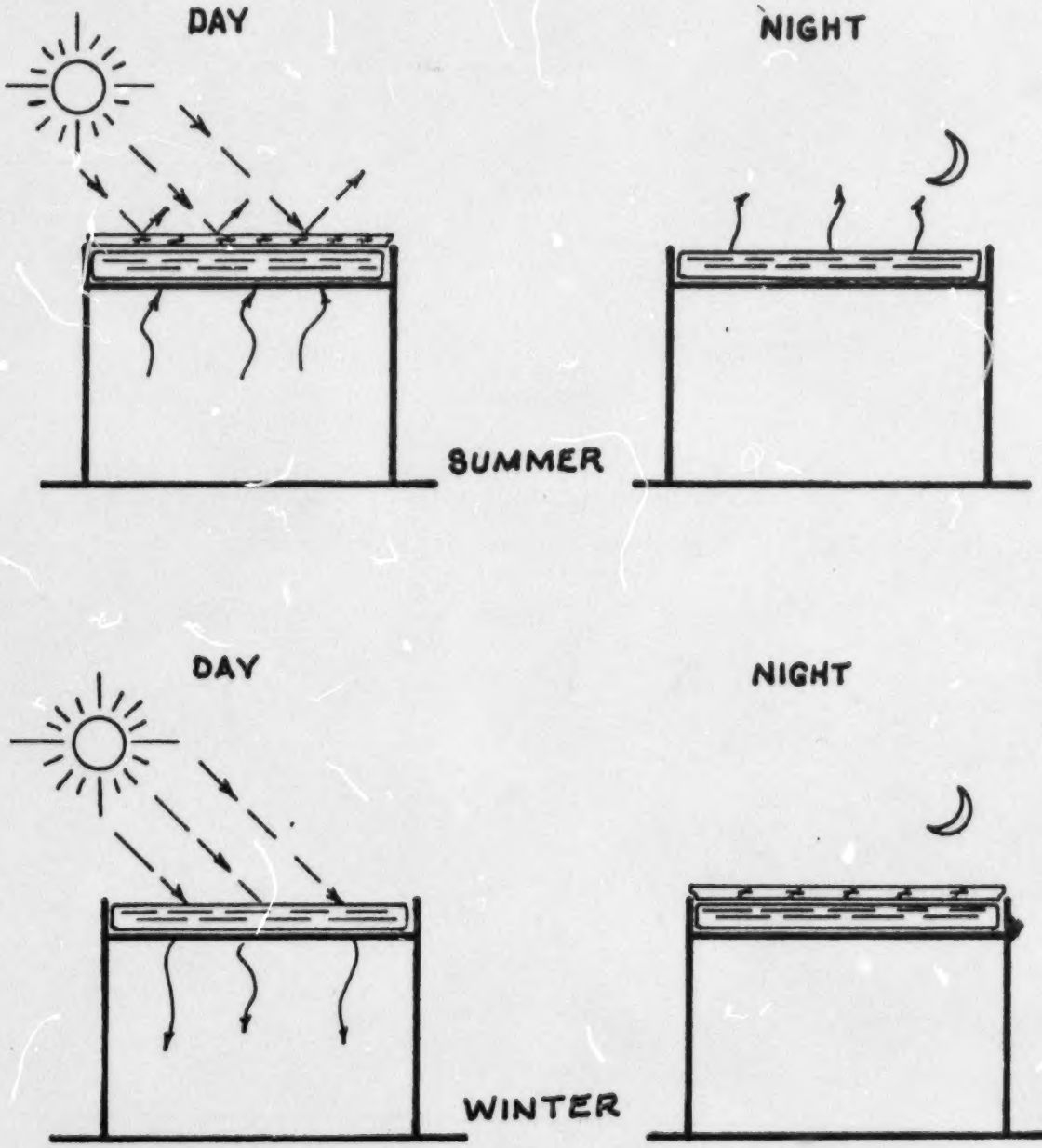

FIG. A-4 -SKYTHERM^{R} - Thermal Storage Roofs, Summer and Winter Operation

SECTION I (PASSIVE SOLAR)

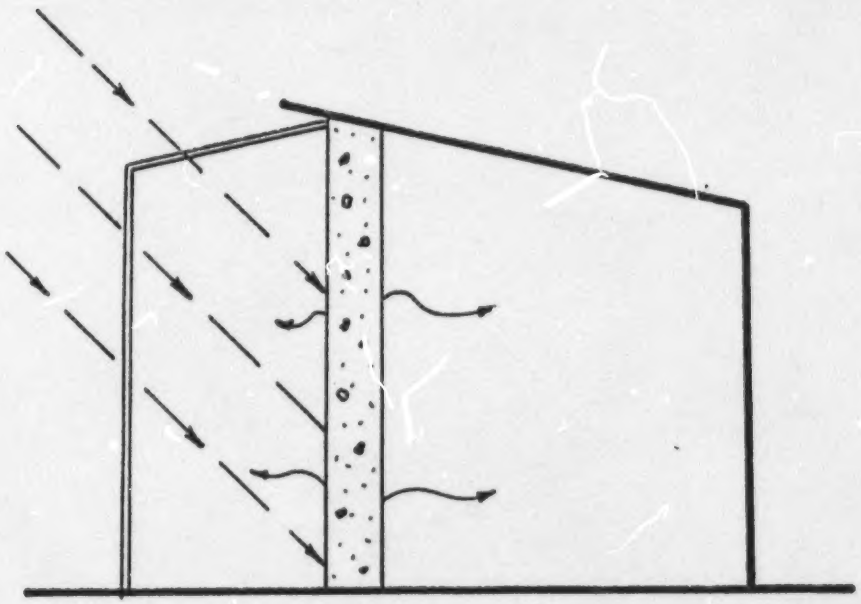

Fig. A-5 - Solar Greenhouse

SECTION II (BUILDING DESIGN)

Assignment No. 1

1. List and explain five (5) guidelines for efficient building design.

---

1. Think small - thinking small is the basic rule for energy efficiency. The smaller your home the less energy it takes to run it.

2. Use efficient shapes - you should enclose as much space as possible with the least amount of wall or roof exposure to the weather.

3. Wise placement - the way your home sits on its land should be determined by the sun and the wind. The main window area of the home should face south.

4. Build underground -a home built underground can take advantage of the fact that the ground temperature a few feet below the surface will remain about 50 degrees all year long. This home would lose little heat in the winter and would remain cool in the summer.

5. Take advantage of landscaping - control the sun and wind exposure by wise placement of trees.

Assignment No. 2

1. Answer the following:
   a. What is insulation?
   b. What are the insulation recommendations for new home construction according to A.P.& L. (Arkansas Power and Light)?
      1) Exterior walls? 2) Ceilings? 3) Floor?

1a. INSULATION is that material used in the building industry to cut down on heat loss in the winter or heat gain in the summer. In most situations it is characterized by being fiberglass batts, cellulose paper, urethane foam, and mineral wool.

1b. The recommendations for new construction are as follows:

1) Exterior walls - R-19 6" fiberglass in the wall.

2) Ceilings - two batts of R-19 6-inch insulation (fiberglass) for a total resistance of R-38.

3) Floors: Crawl space - 6" fiberglass with vapor barrier turned toward heated area. Slab - 1½" urethane board in the slab beneath the outer 20 inches of the horizontal slab perimeter.

SECTION II (BUILDING DESIGN)

Assignment No. 3

1. Answer the following questions:
   a. What are the guidelines for window placement in an energy efficient home?
   b. What types of heating and cooling equipment should be used in energy efficient new home construction?
   c. What is the purpose of humidity control?
   d. What is the purpose of a vapor barrier?
   e. Why should you use attic ventilation?

1a. Window area should not exceed 8 percent of the floor area. Storm windows or insulated glass are recommended. Glass area should be protected by roof overhang.

1b. Heat pump.

1c. Humidity should be controlled because excess moisture may cause mildew to grow on the interior of the home. Too little moisture can cause dry throats in the morning and static electricity in the carpet.

1d. A vapor barrier prevents moisture from entering and condensing in the insulation with resulting mildew or deterioration.

5e. You should use attic ventilators to lower the temperature in the attic, thus reducing the cooling load on the central air-conditioning unit.

Assignment No. 4

1. Answer the following questions:
   a. What was the Arkansas Story?
   b. Who was the designer of the "Arkansas Energy Efficient Home"?
   c. How long did testing on the "Home" go on?
   d. In which state was the "Arkansas Energy Efficient Home" design first implemented?

1a. The Arkansas Story is about the design, construction, and testing of an energy efficient home.

1b. Frank Holtzclaw.

1c. 12 years.

1d. Arkansas.

SECTION II (BUILDING DESIGN)

Assignment No. 5

1. Summarize the features of the Arkansas Energy Conservation Home in Little Rock.

1. The Arkansas energy conservation home in Little Rock is built with 6" stud walls, 24" on center. This allows for compression of 6" of fiberglass insulation in the 5½" walls. These homes have 9 foot exterior walls because of the use of a modified truss that allows for the placement of 12" fiberglass insulation in the attic. The inside walls remain at 8 feet.

One major difference in wall construction is that the total window area of the house must be restricted to 8% of the gross living area. In addition, these must be insulated double pane windows or single windows with a storm window. Plywood headers replace 2" x 8"'s allowing more space for insulation. The trusses, also 24" on center, are required to rest on the top plate directly over the top of the studs. Metal perforated tie plates are used at wood joints and back-up clips are used to hold the gypsum board. A polyethylene vapor barrier completely covers the inside face of both studs and insulation. Foil backed gypsum may be used instead to provide the barrier. Electrical outlets are caulked or taped to the gypsum board.

Note: 2" x 4" walls with 3½" insulation and 1" styrofoam do not meet the Arkansas objective.

Crawl Space and Slab Insulation

Keep in mind that heat flows to colder surfaces or areas. Where walls and ceilings are well insulated, the heat will be attracted to and dissipated by the coldest surface even if this is the floor.

Since people are quickly chilled if their feet feel cold, this tends to make them desire a higher thermostat setting. For both energy management and comfort, the floor areas must be maintained as close as possible to room temperature. It has been found in Little Rock that this requires 6" of insulation over the crawl space or a minimum of 1½" of closed cell polyurethane rigid foam insulation around the perimeter of the slab. In crawl space construction the finish grade must be fully covered with a moisture barrier and since another vapor barrier is installed above the floor insulation, the crawl space must be ventilated.

SECTION III (EXISTING CONSTRUCTION)

Assignment No. 1

1. Use the HOME ENERGY CHECK LIST to evaluate your home and family's energy consumption practices.

   Make a list of all deficiencies that could be corrected in reference to the HOME ENERGY CHECK LIST in your house.

The answer to this question will be left to the teacher's judgement.

CONSERVATION

TEST - SECTION I

NAME_____

DATE_____

GRADE_____

MULTIPLE CHOICE (choose best answer)

___ 1. It is a fact that most housing design today

a. will be energy efficient in the future.
b. can be easily remodeled to be energy efficient.
c. runs the risk of being energy obsolete and overly costly.
d. none of the above

___ 2. The ultimate outcome of increased energy costs will be

a. a slowdown in housing construction.
b. a rising demand for "passive" solar homes.
c. federal government subsidy for home heating bills.
d. none of the above

___ 3. It is important that a student of today learn about "passive" solar design because

a. he will have to know about it to pass this test.
b. many will be faced with the necessity of using it in the future.
c. none of the above
d. all of the above

___ 4. A "passive" solar design may

a. use no exterior power help.
b. use no fans and blowers.
c. use collectors.
d. use a wood stove.
e. all of the above

___ 5. Most of the advantages of a "passive" solar design stem from

a. its inherent simplicity.
b. its greater reliability.
c. its lower material costs.
d. its longer lifetime.
e. all of the above

___ 6. Most of the disadvantages of passive solar design are

a. related to market acceptability.
b. related to increased construction costs.
c. related to lack of public education regarding it.
d. all of the above

___ 7. The most significant reason for passive solar design's cost-effectiveness is

a. the greater glass area needed.
b. the underground construction.
c. the super insulation.
d. the long lifetime.

___ 8. The societal savings from passive solar design include

a. savings of fossil fuels.
b. preservation of resourses.
c. reduction of balance of payments.
d. benefits to the environment.
e. all of the above

___ 9. Direct gain systems

a. use air between glass and blackened absorber.
b. use a plant growing space.
c. use solar radiation that enters through glass or plastic into the space to be heated.
d. none of the above

___ 10. Convective loop systems

a. use air between glass and a blackened absorber.
b. use a plant growing space.
c. use a large water storage wall.
d. none of the above

___ 11. Thermal storage walls

a. use air between glass and a blackened absorber.
b. use a plant growing space.
c. use a large water storage wall.
d. none of the above

___ 12. Thermal storage roof

a. use an "A" frame configuration.
b. use large vinyl water storage bags on the roof.
c. use a large masonry wall for heat storage.
d. none of the above

___ 13. Attached sunspaces

a. use air between glass and blackened absorber plate.
b. use a plant growing space.
c. use a large water storage wall.
d. none of the above

___ 14. The disadvantages of a direct gain passive solar design include all <u>but</u>

a. ultraviolet radiation degration.
b. expensive thermal mass.
c. heat loss at night.
d. glazing serves multiple functions.

___ 15. With the use of thermal storage walls

a. glare and ultraviolet degradation of fabrics are not a problem.
b. temperature swings are lower than "direct gain" or "convective loops".
c. time delay for space heating in the evening.
d. all of the above

CONSERVATION TEST - SECTION I

TRUE OR FALSE (answer by placing T or F on the line provided)

___ 1. Many experts in the field feel that in the very near future a major shift will be undertaken to change from the current techniques of home construction to those that incorporate facets of passive solar energy design.

___ 2. Most housing design today, while trying to incorporate energy saving features, runs the risk of being obsolete and overly costly long before the home has reached its usefulness termination point.

___ 3. It is important that a student of today learn about "passive" solar design because many will be faced with the necessity of using it in the future.

___ 4. Since "passive" systems have few (or no) moving parts and usually employ conventional building materials, their performance is reliable.

___ 5. From the viewpoint of society as a whole, passive solar offers few benefits.

___ 6. The economy will not benefit from the use of passive solar design.

___ 7. Passive solar design do not require increased construction costs.

___ 8. Passive solar construction does not favor the environment.

___ 9. There is a high degree of public knowledge about passive solar design.

___ 10. Passive solar heated homes require the same amount of electricity for operation as do conventional homes.

LISTING

1. List the five (5) basic passive solar design types.

   a. _____ d. _____

   b. _____ e. _____

   c. _____

2. Passive solar design generally do not require:

   a. _____

   b. _____

3. List three (3) advantages to passive solar design.

   a. _____

   b. _____

   c. _____

4. List three (3) disadvantages to passive solar design.

   a. _____

   b. _____

   c. _____

CONSERVATION

TEST - SECTION II

NAME_____

DATE _____

GRADE _____

MULTIPLE CHOICE (choose best answer)

___ 1. The best way to get a home that can cope with the future is

a. design and build it from scratch.
b. buy a pre-built conventional home.
c. remodel an existing home.
d. none of the above

___ 2. The basic principle behind the design of the home should be:

a. Use as small an airconditioner as possible.
b. Build into the south slope of a hillside.
c. The house must gather as much energy as possible from its environment, and then make use of every bit of energy it has gathered.
d. none of the above

___ 3. _____ _____ is the basic rule for energy efficiency.

a. Think large
b. Thinkmedium
c. Think small
d. Think tiny

___ 4. The ideal shape for a home is

a. a rectangle.
b. an "A" frame.
c. a dome.
d. none of the above

___ 5. The main window area for a home that gains heat from the sun should face

a. north.
b. south.
c. east.
d. west.

___ 6. Transpiration means

a. loaning someone your deodorant.
b. throwing the thermometer in the trash can.
c. evaporation through the leaves of a tree.
d. none of the above

___ 7. The use of _____ and _____ for sunscreens is a cheap, natural way to temper your environment.

a. frogs . . . snakes
b. ponds . . . streams
c. trees . . . shrubs
d. none of the above

___ 8. A deciduous tree

a. stays green all year round.
b. looses its leaves in the summer.
c. grows oranges.
d. looses its leaves in the winter.

___ 9. A grouping of deciduous trees can lower air temperature around your home by as much as _____ degrees in the summertime.

a. 10 c. 20
b. 15 d. 25

___ 10. One of the primary concerns of the home owner should be

a. the way house is situated on the building site.
b. the amount of insulation that he has in his home.
c. what type of deadbolt lock is on the front door.
d. none of the above

___ 11. According to the Arkansas Power and Light, the exterior walls should be insulated to

a. R-11 c. R-38
b. R-19 d. none of the above

___ 12. According to the Arkansas Power and Light, the ceilings should be insulated to

a. R-11 c. R-38
b. R-19 d. none of the above

___ 13. According to the Arkansas Power and Light, the recommended insulation for floors over a crawl space or basement is

a. R-11 c. R-38
b. R-19 d. none of the above

___ 14. _____ and _____ are usually the greatest source of heat loss and gain.

a. Dogs . . . cats c. Appliances . . . duct work
b. Ceilings . . . floors d. Doors . . . windows

___ 15. Window area should not exceed _____ percent of the floor area.

a. 4 b. 6 c. 8 d. 10

___ 16. Glass area should be protected by roof overhang, window coating, or other acceptable shading method that will reduce the effect of solar radiation by at least _____ percent during the cooling season.

a. 50 b. 60 c. 70 d. 80

___ 17. Recommended exterior doors should be

a. 1-3/4" steel clad with foamed urethane core.
b. wood door with weather stripping.
c. hollow core door with weather stripping.
d. wood door with cut stained glass and weather stripping.

___ 18. The duct work in an energy efficient home should be located below the ceiling insulation and above a 7-foot high furred down ceiling in the

a. kitchen. b. bathroom. c. garage. d. hallway.

___ 19. A _____ is recommended for most heating and cooling applications in the energy efficient home.

a. central air unit b. window unit c. heat pump d. baseboard heater

___ 20. A _____ is recommended for adequate moisture removal.

a. humidifier b. dehumidifier c. vapor barrier d. electrostatic air filter

___ 21. A continuous vapor barrier should be provided on the heated side of all insulation to

a. prevent moisture from entering and condensing in the insulation.
b. cut down heat loss and heat gain.
c. make the home more energy efficient.
d. all of the above

___ 22. A _____ mil polyethylene vapor barrier is recommended.

a. 10 b. 8 c. 6 d. 2

___ 23. For crawl space construction

a. three polyethylene barriers are required.
b. two polyethylene barriers are required.
c. one polyethylene barrier is required.
d. no polyethylene barriers are required.

___ 24. Power ventilators should be sized to change the air in the attic space

a. 5 times per hour.
b. 5 times per minute.
c. 10 times per hour.
d. 10 times per day.

___ 25. The "Arkansas Story" is a story about

a. the settlement of "Pickles Gap".
b. the Spanish explorations.
c. the rise of the "Confederacy".
d. the design, construction, and testing of an energy efficient home.

____ 26. Today, in many parts of the country, utility costs are (according to text)

a. lower than the home owner's monthly mortgage payments.
b. equal to the home owner's monthly mortgage payments.
c. higher than the home owner's monthly mortgage payments.
d. none of the above

____ 27. The designer of the "Arkansas Home" was

a. Thomas Edison.
b. Frank Broyles.
c. Frank Holtzclaw.
d. Lou Holtz.

____ 28. The walls of the super insulated home are made of

a. 2" x 4" studs 16" on center.
b. 2" x 6" studs 24" on center.
c. 2" x 3" studs 12" on center.
d. 1" x 4" construction grade with foamed insulation board.

____ 29. _____ is used under the sole plate.

a. Caulking
b. Sawdust
c. Insulation board
d. Copper tubing

____ 30. It is claimed that the construction in Little Rock of a "Super Energy Efficient Home" cost _____ than the conventional single story, slab floor home construction it is designed to replace.

a. less
b. no more
c. a little more
d. a great deal more

CONSERVATION

TEST - SECTION III

NAME _____

DATE _____

GRADE _____

MULTIPLE CHOICE (choose best answer)

___ 1. In most circumstances, the battle to make a home more energy efficient

a. will be extremely expensive.
b. will not be very expensive.
c. will be cost prohibitive.
d. will not be nearly as expensive as never making the attempt.

___ 2. The cost of weather stripping and caulking is _____ paid back to you in the form of savings on your energy bill.

a. always
b. sometimes
c. never
d. none of the above

___ 3. _____ homes leak air.

a. All
b. Some
c. Few
d. No

___ 4. The process of unwanted air migration is called

a. ventilation.
b. infiltration.
c. insulation.
d. convection.

___ 5. About _____ of the air in an average insulated house will change every hour.

a. one quarter
b. one half
c. three quarters
d. four fifths

___ 6. Air manages to enter even a modern well built home to change the air completely every

a. two hours.
b. three hours.
c. four hours.
d. twelve hours.

___ 7. _____ is the primary cause of infiltration.

a. Storms
b. Heat
c. Cold weather
d. Wind

___ 8. When wind blows against your house, it creates a strong _____ pressure that can force air into your home.

a. vacuum
b. negative
c. resistance
d. positive

___ 9. The use of _____ cuts down on air infiltration.

a. vapor barriers
b. wood windows
c. garage doors
d. deciduous trees

____ 10. The rule for placement of windbreak is that it should be located at a distance of not more than ____ times the height of your home.

a. two
b. three
c. four
d. five

____ 11. The two worst offenders for infiltration are ____ and _____.

a. windows . . . floors
b. fireplaces . . . doors
c. windows . . . fireplaces
d. ceilings . . . floors

____ 12. When considering weather stripping you should

a. buy the cheapest materials.
b. buy the highest priced materials.
c. buy the highest quality materials the first time you do the job.
d. expect to replace the weather stripping every year.

____ 13. _____ is used as a permanent seal where two different parts of the house meet or where outside air penetrates a house through a crack or hole.

a. Oakum
b. Sawdust
c. Tar
d. Caulking

____ 14. One of the best ways to conserve energy usage in the home is to

a. open all the windows in the summertime.
b. use an attic fan.
c. put 12" of fiberglass insulation in the attic.

____ 15. If you do the installation of insulation yourself, you may be able to save as much as _____ percent on the job.

a. 25
b. 30
c. 40
d. 50

____ 16. You should start applying insulation to the _____ first.

a. subfloor
b. crawl space
c. walls
d. attic

____ 17. Most utility companies are recommending _____ in the attic.

a. R-11 3" fiberglass
b. R-19 6" fiberglass
c. R-38 12" fiberglass
d. none of the above

____ 18. If you are adding insulation to an attic that already has some, you should use

a. unfaced insulation.
b. faced insulation
c. foil faced insulation.
d. foam insulation.

____ 19. The greatest controllable loss from a forced hot air heating system is from

a. the return air system.
b. the condensation in the insulation.
c. the doors and windows.
d. the uninsulated leaking ducts.

____ 20. The air filters in the central air-conditioning system of the home need to be replaced

a. every two months when in use.
b. every six months when in use.
c. once a year.
d. every time the unit is serviced.

____ 21. The common fireplace is

a. a very good heat source.
b. a moderate heat source.
c. a very inefficient heat source.
d. none of the above

____ 22. Depending upon the size, a fire can draw from

a. 3,000 to 15,000 cubic feet of air up the chimney every hour.
b. one to 5 roomfuls up the chimney every hour.
c. both a and b
d. none of the above

____ 23. In the future, air-conditioning costs will

a. become less expensive.
b. stay the same.
c. become cost prohibitive.
d. none of the above

____ 24. You will save about _____ percent of your air-conditioning bill for each degree that you turn up your thermostat in the summer.

a. 1
b. 3
c. 5
d. 7

____ 25. Besides the airconditioner, the _____ is the biggest energy using appliance in the home.

a. water heater
b. dishwasher
c. clothes dryer
d. television

____ 26. An electric dishwasher consumes about _____ gallons of hot water in a normal washing cycle.

a. 10
b. 15
c. 20
d. 25

____ 27. A fluorescent lamp provides _____ to _____ times more light than an incandescent lamp using the same amount of energy.

a. 1 . . . 2
b. 2 . . . 3
c. 3 . . . 4
d. 4 . . . 5

CONSERVATION TEST - SECTION III

TRUE OR FALSE(answer by placing T or F on the line provided)

___ 1. The greater percentage of homes today do not employ energy conservation measures even to a small degree.

___ 2. The best place to start your plan for a home energy conservation program is a comfortable chair.

___ 3. Since we live in the South, we have a shorter cooling season than the northern portion of the United States.

___ 4. In most cases, the battle to make a home energy efficient will not be nearly as expensive as never making the attempt.

___ 5. Not all homes leak air.

___ 6. Infiltration is wanted air migration.

___ 7. About 1/3 of the air in an average insulated house will change every 3 hours.

___ 8. Wind is the primary cause of infiltration.

___ 9. Air that you want to leave the home either by opening a window or turning on a fan is called ventilation.

___ 10. In relation to weather stripping, the cheaper materials are always the best way to go.

___ 11. If you live in an older home you may or may not have insulation in the ceiling.

___ 12. Never caulk when the temperature is below 55 degrees.

___ 13. Blown insulation is one of the most common methods of adding insulation to your home.

___ 14. Fiberglass and mineral wool are fire and vermin proof.

___ 15. The common fireplace is very inefficient when used for heating your home.

CONSERVATION TEST - SECTION III

LISTING

1. List two (2) methods of weatherproofing for your home.

   a. _____

   b. _____

2. List three (3) varieties of weather stripping.

   a. _____

   b. _____

   c. _____

3. List four (4) places where caulking should be applied.

   a. _____

   b. _____

   c. _____

   d. _____

4. List three (3) types of caulking.

   a. _____

   b. _____

   c. _____

5. List three (3) types of insulation.

   a. _____

   b. _____

   c. _____

6. List two (2) types of blown insulation.

   a. _____

   b. _____

7. List two (2) basic ways you can save money on your heating and cooling bill.

   a. _____

   b. _____

8. List two (2) types of air filters.

   a. _____

   b. _____

9. List three (3) ways to improve fireplace efficiency.

   a. _____

   b. _____

   c. _____

10. List five (5) of the BIG TEN energy using appliances.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

MULTIPLE CHOICE

1. C	4. E	7. D	10. A	13. B
2. B	5. E	8. E	11. C	14. D
3. B	6. D	9. C	12. B	15. D

TRUE OR FALSE

1. T	6. F
2. T	7. F
3. T	8. F
4. T	9. F
5. F	10. F

LISTING

1. The five (5) basic passive solar design types:

   a. Direct gain.
   b. Convective loops.
   c. Thermal walls.
   d. Thermal roofs.
   e. Attached sunspaces.

2. Passive solar designs generally do not require:

   a. fans.
   b. pumps.

3. Three (3) advantages to passive solar design:

   a. Saves fossil fuels.
   b. Preserves the economy.
   c. Beneficial to the environment.

   Note: Other advantages mentioned in text acceptable.

4. Three (3) disadvantages to passive solar design:

   a. It increases construction cost.
   b. Buyer wariness due to radical design.
   c. Lack of public education concerning the need for passive solar design.

   Note: Other disadvantages mentioned in text acceptable.

MULTIPLE CHOICE

1. A
2. C
3. C
4. C
5. B
6. C
7. C
8. D
9. B
10. B
11. B
12. C
13. B
14. D
15. C
16. C
17. A
18. D
19. C
20. B
21. A
22. C
23. B
24. C
25. D
26. C
27. C
28. B
29. A
30. B

MULTIPLE CHOICE

1. D
2. A
3. A
4. B
5. B
6. A
7. D
8. D
9. A
10. D
11. C
12. C
13. D
14. C
15. D
16. D
17. C
18. A
19. D
20. A
21. C
22. C
23. C
24. B
25. A
26. D
27. C

TRUE OR FALSE

1. T
2. T
3. F
4. T
5. F
6. F
7. F
8. T
9. T
10. F
11. T
12. T
13. T
14. T
15. T

LISTING

1. Two (2) methods of weatherproofing:

   a. caulking
   b. weather stripping

2. Three (3) varieties of weather stripping:

   a. felt
   b. tubular gasket
   c. foam strips also: flat metal strips

3. Four (4) places where caulking should be applied:

   a. around window frames
   b. at corners formed by two walls with siding
   c. where wire and pipes enter the house
   d. around the foundation

4. Three (3) types of caulking: also: around door frames
   where chimneys or masonry meet siding
   where aluminum storm windows meet window frames

   a. acrylic latex
   b. butyl rubber
   c. silicone rubber

   also: vinyl based
   oil based

5. Three (3) types of insulation:

   a. blankets or batts
   b. loose fill
   c. rigid also: blown

6. Two (2) types of blown insulation:

   a. Mineral fiber also: urea foam
   b. cellulose urethane foam

7. Two (2) basic ways you can save money on heating and cooling bills:

   a. use it less
   b. use it effectively

8. Two (2) types of air filters:

   a. aluminum mesh
   b. fiberglass also: plasticized fiber filters

9. Three (3) ways to improve fireplace efficiency:

   a. glass doors
   b. tight damper
   c. convective grate also: fireplace mirror
      use a firebox unit that has an outside air source

10. Five (5) of the BIG TEN energy using appliances:

    a. water heater also: refrigerator
    b. dishwasher freezer
    c. electric lights ranges and ovens
    d. clothes washer microwave
    e. clothes dryer television
       airconditioner

Dear Teacher:

The evaluation of the completed materials is a critical step in the curriculum development process. It is required that all recipients of the materials prepared by the Alternative Energy Curriculum Project furnish such an evaluation. After you have had time to review this learning packet, complete this questionnaire and return it to the Arkansas Research Coordinating Unit.

This evaluation is for: (Check (✓) one)

( ) Alcohol Fuels ( ) Nuclear Energy ( ) Wind Power

( ) Conservation ( ) Solar Energy

Evaluate each section of the learning packet by placing a check (✓) in the Favorable or Unfavorable column. If the evaluation is Unfavorable, please state the reason in the space beside the section name.

Favorable	Unfavorable		
( )	( )	Information Section	_____
( )	( )	Instructional Materials	_____
( )	( )	Student Study/Assignment Sheets	_____
( )	( )	Tests	_____

Evaluate the following characteristics of the learning packets by placing a check (✓) in the appropriate response.

Readability: ( ) Too High ( ) Too Low ( ) Right Grade Level

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Technical Level: ( ) Too Technical ( ) Too General ( ) Right Technical Level

---

Do you plan to use this material in your classes? Check (✓) Will or Will Not. If Will, supply requested information. If Will Not, state reasons.

( ) Will

Name of Class _____

Grade Level of Class _____

School Name _____

( ) Will Not

Reasons _____

If additional Alternative Energy Curriculum materials would be of use in your classes, check (✓) those energy topics which should be developed.

( ) Bio-Mass ( ) Fuel Cells ( ) Methane ( ) Coal ( ) Geothermal

( ) Other _____

Thank you for your evaluation. Fold this questionnaire so the return address is on the outside. Seal with a small piece of tape. Place a first class stamp in the upper right hand corner and mail.

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IMPORTANT !!!

EVALUATION QUESTIONNAIRE

Place
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